2-3-6-87

REPORT AND RECOMMENDATIONS

of the

Governor's Commission On Technology In Higher Education

Parris N. Glendening
Governor

Annapolis Maryland
September 1998

Governor's Commission on Technology in Higher Education

The Honorable Melvin A. Steinberg
Chair

Mr. Richard Bernstein
President and CEO, BAI Aerosystems

The Honorable Royal Hart
Former Member of the Senate of Maryland

Ms. F. Suzanne Jenniches
Vice President, Electronic Sensors and Systems Division
Northrup Grumman Corporation

Ms. Shirley Q. Marshall
Program Executive, IBM Global Government Industry

Dr. Steven Muller
President-Emeritus, The Johns Hopkins University

Dr. Lynwood P. Randolph
Manager, Information Technology Standards
National Air and Space Administration

Mr. Robert J. Shuman
President and CEO, Maryland Public Television

Dr. Donald J. Slowinski
President-Emeritus, Essex Community College

Ms. Donna S. Stevenson
President, Early Morning Software, Inc.

Mr. Lynn S. Wright
Vice President, Engineering and Technology
Lockheed Martin Federal Systems

Staff to the Commission was Dr. David E. Sumler, Maryland Higher Education Commission, with the assistance of Connie Cox and Greg Stefanelli.

REPORT AND RECOMMENDATIONS

of the

Governor's Commission On Technology In Higher Education

Parris N. Glendening
Governor

The Honorable Melvin A. Steinberg, Chair
Commission on Technology in Higher Education

PREFACE

This *Report* is the product of six months of document review, two days of public hearings, six all-day meetings, additional expert testimony, and many hours of reading, analysis, and discussion by the members of the Governor's Commission on Technology in Higher Education. I wish to personally thank them for their time, effort, and clear thinking.

In the Executive Order creating the Commission, Governor Glendening requested the Commission to

1. Recommend a vision of higher education in the future and the attendant technology needs.

2. Recommend any necessary coordination of technology resources between institutions of higher education.

3. Recommend any organizational structures needed at the State or institutional level for the effective use of technology.

4. Identify the future technology needs of individual institutions of higher education and what resources will be needed in order to allow these institutions to fulfill their missions in the next century.

5. Evaluate the nature of the jobs of the future and the technology resources necessary both to prepare students for the future workplace and the faculty that will be responsible for that preparation.

6. Recommend the appropriate amounts of State expenditures in providing the funding needed to meet these future needs, as well as the appropriate roles of the State and higher education institutions in funding for hardware and software resources, ongoing maintenance, and telecommunications infrastructure in capital projects.

The following *Report and Recommendations* has one section on each of the Governor's areas of interest. Recommendations follow each section. The Commission has not arrived at definitive positions for all of the issues inherent in the Governor's requests. We have attempted to be as clear in our responses as possible. Where we could not find a precise solution, we have suggested the appropriate bodies to do so.

We hope this *Report* is of service to the Governor and the citizens of Maryland. It is now for others to implement our recommendations, which call for a strong commitment from the State to a Maryland Educational Network. We feel this investment will repay the citizens of the State many times over in services and productivity.

Respectfully submitted,

Melvin A. Steinberg
Chair, Governor's Commission on Technology
in Higher Education

Table of Contents

EXECUTIVE SUMMARY

OVERVIEW

For centuries, postsecondary education has been built around the concept of the campus–a central location where scholars gather and students come to learn. This approach began to change after World War II with the development of off-campus centers and "home study" or correspondence courses. The use of satellite communications in the 1970s introduced a new factor: the ability to transmit instruction to any location with receiving equipment.

However, nothing has promised a more far-reaching change in the delivery of education than the digital technologies which are now becoming necessary to the success of educators and students alike. The delivery of instruction using digital technologies is different because it is not site specific. Courses can be delivered simultaneously to many sites rather than being limited to the room where the instructor is present. Because digital technologies travel over telephone lines or other types of cables with greater bandwidth, these technologies are potentially ubiquitous–reaching every place in the world that is connected by a telephone or computer modem.

The trend to distance education and multi-media instruction has led to a profound change in the nature of instructional materials. Not only are individual courses being developed and marketed, but modules within courses are being created for delivery by computer or by video tape. So, as the central campus gives way to courses offered locally in the high school or the home, the traditional courses are, in some instances, giving way to competency-based modules that may be taken separately or combined to earn academic credits.

All of these trends taken together point to a gradual transformation of the collegiate educational enterprise. As more and more students can receive instruction electronically "anywhere/any time," the traditional approach to the educational experience–revolving as it does around a central location and a rigid schedule of courses–will have to give way to a different paradigm which incorporates fluidity, personal choice, and market demand.

With the elimination of geographic boundaries by telecommunications, Maryland's colleges and universities must compete with mega-universities such as England's Open University (which is global in reach) and the University of Phoenix (which is national and seeking to be global). In addition, both state-based and multi-state regional "virtual universities" will be seeking to recruit Maryland residents. Without sufficient technological infrastructure, Maryland's colleges and universities will lose in this competition.

The economic competitiveness of Maryland is at risk if an investment in technology infrastructure is not made. Many states have invested heavily in high-speed digital networks to make their states attractive homes for business and industry. During just the two years 1995-1997, Virginia committed $74 million to a Higher Education Technology Initiative; Pennsylvania committed $21 million to a Link-to-Learn Project; New Jersey appropriated $50 million in bond funds for the creation of statewide and on-campus technology infrastructure; and Georgia designated $43.3 million for technology projects K-16. California, Wisconsin, Florida, Kentucky and more either have built or are building high-speed networks for their educational institutions. Maryland must do likewise or lose ground in the national competition for economic development.

NECESSARY COORDINATION

For Maryland to compete, a Maryland Educational Network must be created. This Network should be a robust, flexible, high speed digital network serving all postsecondary education and public school systems. Such a network, focusing on the delivery of educational services and products, will provide the basis for achieving the vision enunciated by this Commission. Fairly and equitably, it can provide the statewide connectivity necessary to take advantage of the variety and diversity of all of Maryland's colleges and universities. *(The proposed Network is described on pages 21-23.)*

Because the rate of innovation and deployment is so rapid and so capital intensive, it is important that the State assist educational institutions in adapting this new technology to their traditional missions. Maryland needs to add information-age services that are beyond what is routinely available from the telecommunications industry and beyond the normal budget capabilities of educational institutions. This requires aggressive thought and investment just to stay ahead of states that have traditionally been behind Maryland but that are now making significant strategic investments in information technology in support of their educational systems.

In response to our charge from Governor Glendening and because of the urgent importance of the role of telecommunications in postsecondary education, the Commission has focused on that area. However, we are aware of and did consider in our discussions the important relationships between higher education information technology directions and developments both in State government agencies and in business and industry. It is partially because of concerns for these relationships that we recommend that any educational network be standards-based and open to connectivity with other standards-based networks. *(Recommendations on a Maryland Educational Network are found on pages 23-24.)*

ORGANIZATIONAL STRUCTURES

Any management structure developed for the Maryland Educational Network must be sensitive to and representative of the segmental nature of Maryland postsecondary education. The segments are recognized in State law and promote the diversity of education. Testimony presented to the Governor's Commission emphasized the need for a neutral and visionary leadership of an educational network serving all of postsecondary education. While the management of the network might reside or be housed within the University System of Maryland because of special expertise and resources, it was felt that a strong oversight board was needed to assure that all interests were taken into account. *(Recommendations on organizational structures are found on page 27-28.)*

THE NEEDS OF INDIVIDUAL CAMPUSES

To remain technologically current, colleges and universities have had to bear many new categories of expenses that were not present a decade ago. The colleges face large initial investment costs for connectivity and for equipment; high maintenance costs for IT systems including line costs, maintenance contracts, repair and replacement, and technical services; high cyclical renewal costs to replace outdated hardware; and personnel costs for technicians and staff development. *(Recommendations on the needs of campuses are found on page 32-33.)*

TOMORROW'S WORKFORCE

The growth of Maryland's high-tech industry companies is being hampered by a shortage of qualified employees. This is a common problem that Maryland shares with competitor states – demand is far outstripping supply. The problem extends to all levels of employment, from entry level technicians with high school diplomas, to freshly minted college graduates and graduate-trained professionals, to experienced mid-level professionals. Not enough graduates are being generated within the region, and experienced scientists and engineers are the objects of intense competition.

The Commission on Technology in Higher Education believes that, if a broad base of technology workers is to be created, change must occur in the fundamental nature of instruction in colleges and universities. In fact, this change has begun, but it is inhibited by both the strength of traditions and a lack of resources and funding. *(Recommendations on the workforce are found on page 41.)*

A MARYLAND EDUCATIONAL NETWORK

The Commission concluded that a separate educational network is needed for several reasons. A network that serves higher education–especially research universities–must be more advanced than networks designed for the general public or for the operations of State government. Whereas dependability and security may be the priority requirements for a general service telecommunications network; openness, flexibility and speed are the highest priorities for an academic network. Higher education needs to be able to control the allocation of bandwidth because of the great demands for bandwidth inherent in multi-media instruction and advanced research. Experience has also shown that a dedicated educational network with flexibility can be less expensive than a multi-purpose network with varied requirements. Finally, the Commission urges that any educational network be fully compatible with other public networks, sharing common protocols and technical standards. This will permit the sharing of resources when that would be most cost-effective and the easy transmission of data between networks.

FUNDING

To the present, the State of Maryland has had no funds specifically targeted at information technology for higher education. The State has adopted as a first priority the networking of the public schools K-12 and bringing those schools up to a baseline level of technology resources. ***The Commission recommends a $94.3 million 5-year commitment from the State to fund***

1. ***the establishment of a Maryland Educational Network to supply statewide connectivity for all postsecondary education and public school systems;***

2. ***a program to bring all colleges and universities up to a baseline level of information technology resources;***

3. ***innovative programs at public and independent institutions of postsecondary education, including public-private partnerships, innovative applications of technology, workforce training, and renewals of technology; and***

4. ***faculty training and professional development.***

(A summary of funding recommendations is found on pages 48-50.)

REPORT AND RECOMMENDATIONS

of the

Governor's Commission On Technology In Higher Education

I
VISION STATEMENT

Governor's Charge: Recommend a vision of higher education in the future and the attendant technology needs.

The Commission on Technology in Higher Education, in preparing this report and the recommendations which accompany it, has been guided by the following vision of the future of education in Maryland:

Maryland elementary, secondary and postsecondary educational institutions will be provided with information technology infrastructure both statewide and within each institution to assure that

- **any citizen shall have access to the educational services he or she needs or wants at any time and in any place through the use of a combination of electronic technologies regardless of demographic circumstances and geographic location;**

- **every college and university and public school system will have attained a specified baseline level of information technology resources for its students, faculty, and administration;**

- **all students, faculty and appropriate staff shall have access to the Internet and to advanced technology as appropriate for their academic program, their research, and/or their professional tasks;**

- **faculty and staff will receive the on-going training and professional development necessary to effectively use information technology in instruction and administration; and faculty and staff competent in information technology applications will see their working conditions enhanced to reflect their value to the educational enterprise;**

- **public K-12 education, business, industry and the public sector will have rapid and convenient access to information and training available on college and university campuses through telecommunications; and colleges and universities will also benefit from direct telecommunication links with the private sector and government agencies;**

- **these benefits of advanced technology will have been aided by the creation of a Maryland Educational Network providing connectivity to all of postsecondary and public K-12 education which is a high-speed, broadband, digital network, based**

on international standards and protocols, open to other standards-based networks, and flexible enough to adapt to changing technologies.

For centuries, postsecondary education has been built around the concept of the campus–a central location where scholars gather and students come to learn. This approach began to change after World War II with the development of off-campus centers and "home study" or correspondence courses. The use of satellite communications in the 1970s introduced a new factor: the ability to transmit instruction to any location with receiving equipment.

However, nothing has promised a more far-reaching change in the delivery of education than the digital technologies which are now becoming necessary to the success of educators and students alike. The delivery of instruction using digital technologies is different because it is not site specific. Courses can be delivered simultaneously to many sites rather than being limited to the room where the instructor is present. Because digital technologies travel over telephone lines or other types of cables with greater bandwidth, these technologies are potentially ubiquitous–reaching every place in the world that is connected by a telephone or computer modem. Every home, school, and workplace becomes a potential collegiate instructional site. Among the digital technologies are computer online courses, courses offered asynchonously over the Internet, desktop video conferencing, interactive compressed video, and interactive full-motion video. With these technologies, educational access can be provided anywhere, at any time, and at the convenience of the student.

Mike returned home at 9:00 p.m. after a nice dinner that helped him forget the hard day at the auto garage where he works. Settling in front of his computer with a nice tall iced tea, he connected with his Capitol College course on Electrical Engineering. As he reviewed the professor's lecture (which he would later print out), he took notes. Half-way through the lecture he clicked on the interactive exercise that illustrated the lecture. Satisfied that he understood the principles involved in the exercise, he clicked on the lecture again. At the end of the lecture, Mike clicked on a chat room and discussed the course with other students. He had almost completed his degree and had never been on campus.

During the early and mid-1990s, several digital interactive video networks began to connect all of public education in Maryland. These networks include the **University System of Maryland's Interactive Video Network** (39 sites), the **Baltimore Region Community College Instructional Video Network** (9 sites), and the **Maryland Distance Learning Network** (over 100 sites). These networks are discussed in a later chapter.

Online courses are the most recent development in distance education. An increasing number of colleges and universities are making courses available to students through computer networks, especially on the Internet. Only a relatively small number of such courses are now offered, but, certain institutions–especially University of Maryland University College–now offer entire degree programs over the Internet.

Decisions concerning the telecommunications needs of postsecondary education should not be taken without recognition of the developments in information technology in the public schools. Multimedia instruction, Internet access, and distance learning are integral to the *Maryland Plan for Technology in Education.* This five-year plan, developed for the Maryland

Board of Education by the Maryland Blue Ribbon Committee on Technology in Education, sets the vision and strategic direction for technology in Maryland public schools. The goal is to provide access to every learner and for every high school graduate to be information technology literate.

The market for postsecondary education has changed to include ever-increasing numbers of adult, fully-employed students with responsibilities as parents. These students do not have the time needed for commuting to a campus for instruction. They need scheduling flexibility and convenient access to instruction when they, the students, are able to take advantage of it. Interactive video courses offered by colleges in the local high school or a regional higher education center can provide such access to these individuals. Computer online courses offered asynchronously allow a working parent to take the courses at home at a convenient time, not at the convenience of the instructors or the colleges offering the courses. The present workforce is constantly in need of training and retraining. The necessary short-courses, workshops, seminars and contract training are ideally suited to distance education.

Betty rushed down the hall of Northern Garrett High School. This was something she looked forward to each week. She was so relieved when Frostburg State University began offering graduate courses in educational administration by interactive video at Northern Garrett High. Prior to that she had to drive to Frostburg every Tuesday regardless of the weather to take her required continuing professional development. Now, she could just walk down the hall after her last class was finished. She especially liked the fact that she was able to interact with her friends and fellow teachers who were taking the same course simultaneously at Southern Garrett High school in Oakland and Fort Hill High School in Cumberland. She had heard that her Principal also used the same teleclassroom to meet with other principals from Allegany and Washington Counties." Wow," she thought, "it is amazing how much time has been saved by the interactive classroom." Betty was even considering teaching a course on the distance learning system herself next fall.

The trend to distance education and multimedia instruction has led to a profound change in the nature of instructional materials. Not only are individual courses being developed and marketed, but modules within courses are being created for delivery by computer or by videotape. So, as the central campus gives way to courses offered locally in the high school or the home, the traditional courses are, in some instances, giving way to competency-based modules that may be taken separately or combined to earn academic credits.

All of these trends taken together point to a gradual transformation of the collegiate educational enterprise. As more and more students can receive instruction electronically "anywhere/any time," the traditional approach to the educational experience–revolving as it does around a central location and a rigid schedule of courses–will have to give way to a different paradigm which incorporates fluidity, personal choice, and market demand. The concept of a course as the total creation of one instructor will be challenged as instructors incorporate more commercially available multimedia products (video clips, CDs, computerized instruction on a single topic) into their courses. In fact, the proposed educational experiment being considered by several western states–the Western

Governors' University–dispenses with the course structure and provides students with many alternatives to demonstrate and certify their mastery of "competencies" required for a college degree.

Traditional campuses offering traditional classroom instruction will continue to grow in the next decades. They will need additional facilities to accommodate the increase in high school graduates who will still seek a traditional college experience. However, the number of adult learners studying on the traditional campus will gradually decrease as the advantages of distance education – online courses and courses by interactive video in a neighborhood high school or higher education center – become more widely available. Eventually, the need for increased investments in bricks and mortar should diminish.

The digital revolution has also changed irrevocably the student services and administrative services of colleges and universities. Now a student need not visit a campus and wait in line to register, to receive counseling, or to buy books and instructional materials. All of this can be done from home over the Internet. Distance is irrelevant. Moreover, the college's administrative processes can be interconnected through local area networks on campus to expedite purchasing, personnel actions, and record keeping. Virtual libraries can provide students with online access to the combined collections of all Maryland colleges and universities as well as to online journals.

The role of higher education as an engine of economic development has become increasingly crucial. Information has become the most precious commodity in the Information Age, and colleges and universities are in the information business. Colleges can provide online courses and interactive video instruction to the workplace. Academic researchers can be in touch with scientists and technicians in private industry through e-mail and exchange data electronically.

Most critically, higher education must supply the technical specialists needed by business and industry in all fields. As society becomes increasingly dependent on computers for all information transactions, the need for trained technicians as well as computer scientists and computer and system engineers grows. And, as all professions become more automated, all educated individuals must have a familiarity with computer usage.

Dr. Barnes is not sure how many of these multimedia course development projects she will participate in; but the first two have been interesting. It is very different being just one member of a development team to produce a course that someone else may teach!!! Once, she was the sole author of her courses. Then, she would present them to her students without help from outside the classroom. Now, she has supplied the intellectual content for two courses on politics in developing countries, but she worked with an instructional designer, a computer graphics expert, and an actor to create an interactive CD-ROM for use by her university. The CD-ROM contained not only Dr. Barnes' lectures, but also supplementary reading materials and video clips of political leaders and news events in the countries being studied. Dr. Barnes had not yet decided if she would agree to the University's request to market the courses nationally; but she was giving it serious thought.

Competition has been heightened by advanced technologies in several ways:

- ***Competition among institutions of higher education*** for the most rapidly growing sector of the education market–fully employed adults seeking education and training for advancement–without regard for geography or state boundaries.

- ***Competition among states*** for businesses and industry dependent on a highly skilled, technology-proficient workforce.

With the elimination of geographical boundaries by telecommunications, Maryland's colleges and universities must compete with mega-universities such as England's Open University (which is global in reach) and the University of Phoenix (which is national and seeking to be global). In addition, both state-based and multi-state regional "virtual universities" will be seeking to recruit Maryland residents. Without sufficient technological infrastructure, Maryland's colleges and universities will lose in this competition.

The economic competitiveness of Maryland is at risk if an investment in technology infrastructure is not made. A national study by Hezel Associates of telecommunications funding during a two-year period, 1995-1997, documents that many states have recently invested heavily in high-speed digital networks to make their states attractive homes for business and industry. In just the past two years, Virginia has committed $74 million to a Higher Education Technology Initiative; Pennsylvania has committed $21 million to a Link-to-Learn Project; New Jersey has appropriated $50 million in bond funds for the creation of statewide and on-campus technology infrastructure (a $100 million programs with required matching funds); and Georgia has designated $43.3 million for technology projects K-16. California, Wisconsin, Florida, Kentucky and more either have built or are building high-speed networks for their educational institutions. Maryland must do likewise or lose ground in the national competition for economic development.

The following chapters of this report provide our recommendations as to how Maryland can fulfill the vision stated above.

II
NECESSARY COORDINATION

***Governor's Charge**: Recommend any necessary coordination of technology resources between institutions of higher education.*

EXISTING EDUCATIONAL NETWORKS IN MARYLAND

Educational networks throughout Maryland encompass a broad range of limited capability technologies, both in terms of the medium used, as well as the currency of the technology. They range from traditional television broadcasts to digital satellite, from remote access to host computers, to Internet and Web connections to high bandwidth fiber-optic cable connections. In most cases, these networks are separate and under separate auspices and management and are used in different educational settings. In some cases, multiple networks are used in concert by a single educational institution. Typically this is a video network and a data network used in the same setting; although several institutions belong to two interactive video networks.

The following text provides an overview of the major networks used within the State of Maryland presently. Table 1 (pages 12-13) gives a snap shot of more educational telecommunications technologies, how they are used, and their strengths and weaknesses.

UNIVERSITY OF MARYLAND ACADEMIC TELECOMMUNICATIONS SYSTEM

Over the past eight (8) years, the University System of Maryland (USM) has conceived, implemented and enhanced a telecommunication network that ties thirteen (13) institutions together, providing data, video and Internet access. By pooling funds, combining technical expertise, and establishing committees and working groups of institutional members, each university has gained great benefits from its investment in this communication infrastructure.

The University of Maryland Academic Telecommunications System (UMATS) is a data, video and satellite network connecting the campuses and research institutes of the University System and several community colleges and public schools. Through this network, instructional programs, credit and non-credit courses, and professional education programs for students of the USM campuses, K-12 and higher education faculty, and the general public are provided. The instructional application of UMATS is referred to as the **Interactive Video Network (IVN).** UMATS eliminates the need for a campus to worry about interconnections. UMATS pays for and supports all hardware and software between campuses and provides access to national and international connectivity. Institutions contribute to UMATS proportionate to their size.

UMATS has two other major applications:

> **LIMS** or Library Information Management System, which contains an online catalog for the USM's 11 colleges and universities as well as St.Mary's College of Maryland and Morgan State University.
>
> **Administrative Applications** to support management of the 11 campuses, two research institutes, and Central Administration.

Some characteristics of UMATS are:

- Development is guided by the University System of Maryland Central Administration
- A variety of technologies are used, such as frame relay, ATM, wireless and SMDS
- USM institutions contribute based on their size of budget and number of students
- Distance-insensitive monthly line charges to other higher education agencies are used; a flat rate is under consideration.

The UMATS is now at a stage of its development where it must be upgraded to take advantage of Internet2. The USM is required to acquire greater bandwidth capable of handling the greater speeds of Internet2. This will require the USM to migrate from a T-1 network to an OC-3 network which is scaleable up to OC-48. The USM will be creating on a smaller scale the type of network that other states have created for all of public education K-16; ***but, because an upgraded UMATS would include just the USM and not all educational institutions, Maryland would not be maximizing its economies of scale and purchasing leverage, as other states have, unless a comprehensive Maryland Educational Network is developed.***

UNIVERSITY SYSTEM OF MARYLAND INTERACTIVE VIDEO NETWORK

The instructional application of UMATS is the Interactive Video Network (IVN), an interactive videoconferencing network providing distance learning capabilities to University of Maryland campuses. The system is designed around a compressed video network protocol. Some community colleges have joined the USM network. At present, it has about 39 sites. Computer online courses are also offered over this network. Since this is a standards-based network, it allows access to any other national or international network conforming to international standards.

IVN is a multipoint network. Although only one distant site can be seen at any given point in time, all sites are interactive; and the voice-activated video switches from site to site. Because of the small amount of bandwidth used by this technology, the quality of video is not equal to broadcast video. The broken image makes this a less desirable technology for public schools; although adult learners quickly adapt to it and give it high ratings as an educational technology.

Each institution is responsible for on-site facilities and service, such as meeting coordination, technical support and end-user training.

The following are general aspects of IVN:

- Connects 30 institutions of higher learning and several public schools with 39 sites.
- Supports video applications at T1 rates
- Video sessions are scheduled through a central system maintained by the USM
- Distance-sensitive pricing for T1 lines to higher education institutions is under consideration.

MARYLAND DISTANCE LEARNING NETWORK

The Maryland Distance Learning Network (MDLN) is a proprietary, switched fiber optic network providing full motion, interactive video and audio to all participating sites. The intent is that all public high schools, colleges and universities could potentially belong to the network. It also includes cultural institutions and medical facilities. There are now around 100 sites operational or being installed. The MDLN connectivity is owned, managed and maintained by Bell Atlantic-Maryland.

The MDLN is a public-private partnership between the State and Bell Atlantic-Maryland for which there has been no direct State appropriation. Estimated sites on a mature network would include around 200 high schools and vo-tech centers, 40 public higher education sites, at least 10 independent colleges and universities, 15 cultural and scientific organizations, 10 hospitals and/or clinics, some State agencies, and several correctional facilities.

The MDLN is a broadband digital network carried on three DS-3 lines into each site. This provides full-motion interactive video and interactive audio without distortion. Programming can originate from and be received by any site on the network. Operating through coder-decoders (or "codecs") at each site, and because it is based on digital technology, the network can integrate any other video source material at analog baseband, including cable, satellite, and compressed video.

The MDLN provides any-user to any-user video connectivity because it is based on a switched architecture which allows any site to "call" any other site. This interconnectivity between any-user to any-user is based on MDLN being a closed system; that is, only those individuals tied together through the network can be connected. At present, the MDLN provides for a maximum four sites to be fully interactive during any one session, with an unlimited number of other sites receiving the same session in broadcast mode (receive only). The Network also permits multiple separate sessions to be planned in advance and allows automatic switching to occur at a programmed time. The MDLN is a "ubiquitous" network in that sites may be established anywhere in the State and the capabilities of each site are the same.

Equity is assured by a pricing structure that is the same regardless of site location and amount of usage. The monthly line tariff for local access for one site is $1,495. AT&T and Bell Atlantic have partnered with the State to provide long distance, cross-LATA connections for an additional $395 per month per site.

General characteristics include:

- Connects to 47 public schools, 34 higher education sites and 10 medical and cultural organizations
- Supports video applications at rates up to OC-3 (155 Mbps) providing full-motion video
- Video sessions are scheduled through a Bell Atlantic central control facility
- Partnership venture between the State of Maryland and Bell Atlantic
- Bell Atlantic performs network services such as connections, help desk, lines, equipment and maintenance.

MARYLAND NATIONAL GUARD DISTRIBUTIVE TRAINING TECHNOLOGY SYSTEM

The Maryland National Guard (MDNG) Distributive Training Technology System (DTT) is an ATM standards-based video, audio, and data transmission system connected to an international ATM network in all 50 states, four United States territories, and NATO member and NATO partner countries. It is projected that over 20 sites in Maryland will be directly connected with ATM switches. Any college or university that develops a partnership with the MDNG will be invited to connect with the DTT *via* T-1 or ISDN dial-up.

Presently Maryland sites on the DTT exist in Laurel, Reisterstown, Essex, Silver Spring, Edgewood, Glen Arm, Oakland, and Salisbury. Fourteen additional sites are being planned around Maryland. Several colleges and universities are teaching courses over the DTT for the general public, not just for Guard members. Also colleges and universities as well as public service organizations have used the National Guard Network for conferences and meetings.

The DTT is designed in such a way that the Guard is able to provide local communities access for education, telemedicine, telecommuting, and public services. The Guard

Table 1

Characteristics of Technologies Used for Educational Networks in Maryland

Options	Technology	Costs	Participants	Funding	Strengths and Weaknesses
Maryland Distance Learning Network (MDLN) (Management - Bell Atlantic-MD public-private partnership; Presently under State contract)	Switched fiber-optic network; full motion, interactive video and audio carried on three DS-3 lines into each site; transmission to four sites simultaneously (connections to other sites as view only are possible); supports data applications at rates up to OC3	Teleclassroom construction + monthly line tariff for local access and additional long distance charges for cross-lata connections; faculty training and compensation	Approx. 100 sites; Primary users: public schools, community colleges; Other users: some universities and State agencies, cultural centers and medical facilities	No direct State appropriations; individual sites bear costs; some MHEC grant $ have supported facilities preparation	**Strengths:** High quality multi-site video/audio interaction **Weaknesses:** Limited to Maryland only; Proprietary
U.M.A.T.S. (Management - University System of Maryland) One of the applications of U.M.A.T.S. is the Interactive Video Network (IVN)	Compressed video and video to desktop; supports data, satellite, and video applications, TCP/IP; supports online library catalog, administrative functions, and Internet access; uses newer technologies such as frame relay, ATM, wireless, and SMDS	Teleclassroom construction; distance-insensitive monthly line charges; network costs; faculty training and compensation	USM - 13 institutions and central administration	Institutional budgets	**Strengths:** Standards-based, allows global connections; Video, audio, and data transmission **Weaknesses:** Distortion in video/audio
Interactive Video Network (IVN) (Management - University System of Maryland)	USM application for compressed video; point-to-point connecting with one distant site at one time (broadcast to other sites is possible);video, audio and data transmission	Teleclassroom construction; network costs; faculty training and compensation	Approx.40 sites; USM campuses; some community colleges	Institutional budgets	**Strengths:** Video, audio, and data transmission; Standards-based **Weaknesses:** Only two sites viewed at one time;; Distortion in video/audio

Options	Technology	Costs	Participants	Funding	Strengths and Weaknesses
National Guard System (Management - National Guard)	Compressed video; point-to-point connecting with one distant site at one time (broadcast to other sites possible); video, audio and data transmission; Internet access ATM technology; standards-based	Teleclassroom construction; network costs; faculty training and compensation	National Guard locations; some colleges and universities joining network to use when available	Institutional budgets; some grant $ available	**Strengths:** ATM switching; Video, audio, and data transmission; Standards-based, national and international links possible. **Weaknesses:** Distortions in video/audio; Limited participation
Microwave (UMCP College of Engineering)	Narrow broadcast signal on a line-of-sight from one receiving tower to the next; transmits data and audio with the aid of a telephone bridge	Capital costs - towers, studios	Limited: UMCP College of Engineering	Institutional budget	**Strengths:** Mature network serving private industry **Weaknesses:** Limited participation; Capital intensive
Satellite/Broadcast (Management - Consortium of colleges and Maryland Public Television; Agreements with satellite producers)	Transmission from originating studio to many points simultaneously; analog video does not permit interactivity; (Digital satellite service will provide for interactive video , voice, and data)	Varies with agreements with Maryland Public Television and satellite producers	Primary users: community colleges; Other users: UMUC; colleges and universities, and public schools	Institutional budgets	**Strengths:** Varied programming; Reaches statewide **Weaknesses:** Analog lacks interactivity
Cable (Management -Local cable companies)	Analog system; one-way video and audio only (Future digital cable may offer wider services)	Varies with agreements between cable companies and users; costs of cable studio	Most county community colleges and public schools; UMUC	Institutional budgets	**Strengths:** Varied programming; Full motion **Weaknesses:** Limited to local jurisdictions; Lacks interactivity
Sailor (Management - Maryland State Department of Education - Library Services)	Backbone of double T1 connections to every county in the State; supports data applications	User computer, modem, and phone line; access free of charge to all consumers	Public libraries, public school systems, and many municipal, county, and state agencies	State and Federal $	**Strengths:** Large resource base; Free of charge service; Standards-based **Weaknesses:** No video application

network is funded by federal appropriations. Individual sites at armories are funded by many sources, with federal funds predominating.

SAILOR NETWORK

The SAILOR Network is a statewide data network, providing public access to the Internet and to library catalogs statewide, developed by the Maryland Department of Education - Library Services unit. Presently, network management resides at the Enoch Pratt Library, which receives State funding as the State Library Resource Center. The primary customer base is public libraries and their patrons statewide. More and more educational institutions, especially K-12, are now being served. The SAILOR Network is provided free of charge to all consumers.

General characteristics include:

- Connects to 45 public schools, 184 K-12 classrooms with 572 workstations, 1 community college, and 27 public libraries
- Supports data applications only
- Combines Federal grant funds and State direct funds for network support
- ATM and SONET are planned.

NETWORK SOLUTIONS IN OTHER STATES

Educational networks among the states encompass a broad range of technologies, both in terms of the medium used, as well as the currency and capacity of the technology. They range from traditional television broadcasts to digital satellite, from remote access to host computers, to Internet and Web connections, from mailed videotapes to interactive video over telephone lines, and from low capacity dial connections to high bandwidth fiber-optic cable connections. In most cases, these networks are separate and under separate auspices and management and are used in different educational settings. In a few cases, multiple networks (usually two) are used in concert in a single educational setting. Typically, this is a video network and a data network in the same setting.

Most states have implemented and/or are planning for newer technologies such as digital satellite, ATM and wireless systems. High bandwidth backbones are a challenging issue in most states. Such backbones are expected to handle multimedia, including video. Interactive video is an increasingly popular tool for instruction as well as business and administration. A few states have implemented statewide ubiquitous access systems, making it possible for individuals to reach educational networks from virtually anywhere.

LIMITATIONS OF THE CURRENT ENVIRONMENT

The bandwidth available on university campuses has expanded steadily over the last ten years. This increase has naturally caused a need to support higher bandwidths on the wide-area networks linking many campuses. Existing Ethernet LANs on campuses are more heavily loaded than just a few years ago. Furthermore, much of the traffic is now destined for information resources off-campus as advances in networking blur the boundaries of each institution. In California, for instance, the ratio of campus bandwidth to wide area bandwidth was (in 1994, before the latest upgrade) about 8:1, given an Ethernet LAN and a T-1 wide area network. This is roughly equivalent to the situation in Maryland today. The introduction of more ambitious campus networks (especially with ATM switching) demand a wide-area network with significantly more capacity than today's T-1 based architecture.

In addition to demands placed on a typical statewide network by traditional data applications, many states are finding that there is an increasing utilization of two-way compressed video also competing for bandwidth.

Multimedia databases containing high-quality images and video clips were difficult to construct only a few years ago. Now, they are quite feasible and relatively simple to operate. Today's traditional Ethernet LANs are barely able to support such applications and are being targeted by campuses for upgrades to higher speeds. Faculty at other campuses may also desire access to the multimedia databases of a connected campus. Hence, the network must be prepared to support such future activities.

The network solutions from California, Georgia, Florida, Illinois, and New Jersey will be discussed in order to establish a perspective on the approach each of these states has taken in creating the necessary infrastructure for the next century.

CALIFORNIA'S NETWORK SOLUTION

California has two higher education high-speed networks–one for its research universities and one for the California State University System (CSU), the community colleges, and public schools. The chief executive of the CSU network appeared before the Commission on Technology in Higher Education and described the network that serves most of California's educational institutions K-doctorate.

Collectively, the campuses of the California State University (CSU) system have addressed many of their needs (e.g., Internet access, two-way compressed video, etc.) for inter-campus connectivity and services with an integrated system of technology called 4CNet (formerly CSUnet). However, in addition to 4CNet, each campus has installed C and Ku band satellite downlinks; 14 campuses have installed Instructional Fixed Television Service (IFTS) omni-directional and directional microwave stations, some with multiple channel capacity; and four northern campuses are connected on a private microwave system known as the Central Valley Microwave Network. A number of campuses are also linked by point-to-point microwave, ITFS or coaxial cable to local or regional cable television companies or wireless cable operators; several campuses are connected by temporary or dedicated microwave systems to commercial uplinks; and one site has two dedicated earth stations supporting C and Ku band transmissions while one site has provided *transportable* Ku uplink services as the custodian of the CSU Mobile Satellite Unit. Added to these services and systems are the more common mass media outlets such as a broadcast radio and television. CSU campuses operate more than nine FM public radio licenses, one UHF public television station, and soon, a low power television station.

As detailed above, the technology used by the CSU campuses has changed substantially over the last eight years in concert with the changing needs and requirements of the CSU faculty and students. This continual reinventing of the technology and services under the service mark of 4CNet, the Central Valley Microwave Network and others, is a continuing process as the CSU campuses evolve their inter-campus information needs.

Presently, the core of 4CNet is based on advanced cell and frame relay technologies. It is based on ATM technology for switching and SONET architecture for connectivity.. Two-way compressed video conferencing is supported, including access to the University of California's video network as well as over 2,000 Sprint Meeting Channel rooms worldwide. The Wide-Area Network is composed of various vendors' equipment and services.

The CSUs current network infrastructure fully supports data, video, voice, and image communication among campuses. Data communications is supported using a variety of leading protocols. Campuses have full, high-speed access to the NSFnet Internet and emerging research and education programs. Regarding video, the network switches installed at each campus and at some off-campus centers allow campuses to manually schedule two-way compressed video sessions with any other suitably-equipped campus as well as with Sprint Meeting Channel public rooms across the nation.

The next generation network, The California Research and Education Network; Phase 2 (CalREN-2), is establishing high capacity advanced network services to support new classes of applications that cannot function on the current commercial Internet infrastructure. The CalREN-2 network is compatible with the emerging Internet2 architecture and will interconnect seamlessly with the national Internet2 infrastructure when that is established. Additionally, services required by California research universities may also be provided over the CalREN-2 infrastructure.

Pacific Bell, a California-based telecommunications provider, has arranged for substantial discounts for members of the Consortium for Education Network Initiatives in California (CENIC) to its high speed network services. This will enable CalREN-2 to implement a 2.4 gigabit per second network within specific geographical SONET rings.

In summary, the primary support responsibilities of 4CNet includes the following elements:

- The 4CNet Network Operations Center is staffed 7x24 and responds to trouble reports within one hour. Subscribers receive state-of-the-art technical support, including software updates and configuration changes, fault isolation, and trouble resolution. A trouble ticket system is used to track problems from initial report to resolution, and keep subscribers informed of network status. Twenty-four hour a day hotline service assures access when problems occur.

- Provides Web pages with general network information, performance data, and a Web-based interface for placing and tracking trouble reports and service requests.

- Operates a state-of-the-art network management system that will alert 4CNet staff to out-of-specification conditions and facilitate proactive network management.

- Is responsible for monitoring, analyzing, reporting of network capacity and performance, and for ensuring that the activities of one site do not degrade the backbone access of other sites. 4CNet is responsible for the integrity of the network under all conditions, and will take appropriate action to maintain it.

- Plans and implements network backbone upgrades to maintain agreed upon levels of performance throughout the system.

- Coordinates all equipment and circuit maintenance contracts, including emergency replacement, repair, and shipping.

- Provides adequate backup power at the Network Operations Center in the event of a utility power failure.

- Provides information services to all hub and end-site contacts as appropriate.

GEORGIA'S NETWORK SOLUTION

In Georgia statewide networking for all public education is managed by the Office of Information and Instructional Technology (OIIT) of the University System of Georgia Board of Regents. The OIIT oversees two major networks: PeachNet for data and Internet access, and GSAMS for instructional video and teleconferencing.

According to the Hezel Association's study of State Funding for Higher Education Technology 1995-96 and 1996-97, Georgia has provided substantial funding from a variety of sources for its technology infrastructure – nearly $44 million between 1995 and 1997. In addition, Georgia has been creative in the ways schools can save money for essential services such as a 40% to 80% reduction in telephone service rates under the Classroom Communication Service Plan of Southern Bell approved by the Georgia Public Service Commission.

PeachNet is a statewide data communications network providing inter-campus communications and access to external computing resources to each of the University System's 34 institutions, as well as to the K-12 and public library communities. Initially tested in 1988, PeachNet's backbone has grown to be an expansive network of more than 80 routers connected via T1 lines. The Network routes TCP/IP and AppleTalk communications protocols and is connected to the Internet through its connection to SURAnet, an NSFNET mid-level network. Independent colleges and universities in Georgia are able to join PeachNet as full participants.

The Georgia Statewide Academic and Medical System (GSAMS), a fully interactive video teleconferencing system, includes a distance learning network and a telemedicine network funded by the 1992 Distance Learning and Telemedicine Act to improve access to education and medical care. The combined network is managed by the Department of Administrative Services of the University of Georgia to serve K-12 public schools, colleges, universities, technical schools, hospitals, prisons, Georgia Public Television, and ZooAtlanta. The distance learning network includes over 200 sites, and the telemedicine network includes over 50 sites. The Distance Learning and Telecommunications Board has agreed to fund an additional 125 sites and the Board of Regents will fund about 40 sites.

The latest development in Georgia is the development of the GALILEO virtual library project. Through a website maintained by the University System of Georgia OIIT, public access to the library collections of the 34 University System campuses and of other Georgia colleges has been automated. This automation includes not only catalog access but also access to more than twenty databases open to the general public and 100 more databases open to educational institutions who pay for this access. These databases provide access to citations, abstracts, and full-text articles from thousands of periodicals and journals.

FLORIDA'S NETWORK SOLUTION

The intent of the Florida Distance Learning Network (FDLN) is for it to be a "virtual university, virtual school, virtual community college, virtual corporate training center." It is not a free-standing new institution; it is not limited to serving any one geographic location in the state; and it does not have a teaching faculty or its own communications technologies. Instead, FDLN is a network of teachers, trainers, and learners located throughout the state linked by existing communications technologies and networks, including such existing networks as Florida Remote Learning Service (FRLS) and Florida Information Resource Network (FIRN) working together to produce valid and useful specific programs and deliver them across the State.

The FDLN is administered by a small coordinating center called the Coordinating Center for Distance Learning (CCDL). The CCDL has organized six Advisory Committees, consisting of representatives of FDLN member institutions.

FDLN is accountable to a Board of Governors, which is the primary policy making body. The Board is made up of representatives from the constituent institutional members, with equal representation of the three sectors of public education in Florida, i.e. K-12, community colleges, and state universities, with representation also from public agencies and the private corporate sector. Members of the Board of Governors rotate every three to five years.

Since there is no permanent full-time staff to design and deliver programs or to advise students, FDLN recruits people to undertake these integrated services on a part-time, temporary, and project by project basis. In this way the Network not only remains highly cost efficient, but also remains highly sensitive to emerging and changing learning needs and supplements and enhances the activities of established educational agencies.

As an entity of the State, FDLN and the Board of Governors is a public corporation, created by statute. In Florida, public corporations are often established to carry out various functions of government, such as, in this case, the oversight and coordination of distance learning.

ILLINOIS' NETWORK SOLUTION

In 1997, Illinois embarked on a rather aggressive approach at revolutionizing the statewide network under the Illinois Century Network name. Creative, aggressive use of advanced technology is to transform higher education in Illinois by providing two distinct advantages: (1) new, more adaptive media to enhance learning and (2) communications capacity to extend opportunity everywhere in the state.

The State of Illinois proposes the Illinois Century Network as a program of network services at sufficient scale to provide its citizens with essentially universal access to education and information resources at reasonable cost. The Illinois Century Network will connect every higher education institution in Illinois to a very high bandwidth network, giving citizens statewide access to higher education, advanced training and the growing global wealth of electronically available material. It will build upon the state's earlier technology investments, integrating them and multiplying their effectiveness as it also provides new, unique capabilities.

The Illinois Century Network concept is designed to increase higher education's interaction with society. Central to the value of technological advancement will be its ability to link higher education to elementary and secondary education, public libraries, hospitals, governments, government agencies, industry, corporations, small businesses and individual citizens. The Illinois Century Network will build upon the initiatives already under way by the Illinois State Board of Education to deploy a statewide elementary and secondary school network; by the Central Management Services to establish a statewide telecommunications network; by the Illinois State Library to link learners with libraries in Illinois; and by regional and local higher education and community networks springing up across Illinois. Illinois must develop the infrastructure necessary to integrate and coordinate the networking initiatives spearheaded by different public sectors of education because that integration will be crucial to the future success of educational technologies. That success in turn will be crucial to the state's ability to sustain leadership in the quality of its education and to meet the lifelong learning and training needs of a technologically advanced economy.

Colleges and universities have already invested heavily in early generations of networking, in both campus networks and basic connectivity to the Internet. Under a National Science Foundation program, over 100 Illinois institutions received grants for their initial Internet connections. Basic connections are, therefore, no longer a pressing issue for most of higher education. (The same is not true for elementary and secondary schools, where fewer than half have connections or local networks.)

But this initial generation of connections supported traffic primarily in the form of text. As images became more dominant in the traffic, the capacity requirements increased dramatically. As users convert from still images to moving pictures and sound, capacity will need to increase again. It is these more recent capabilities that have multiplied the power of the Internet as an educational medium, and Illinois does not have statewide the level of network connectivity necessary to seize these opportunities. The Internet2 project is likely to provide federal support only to the major research universities and for some educational experiments. Broader availability of this advanced technology will be primarily the responsibility of individual institutions and their regular sources of funding. The Illinois Century Network would meet the responsibility for Illinois institutions.

NEW JERSEY'S NETWORK SOLUTION

According to the Hezel Association's Report on State Funding for Higher Education Technology, New Jersey has committed an impressive amount of funds to supporting its education infrastructure. Specifically, in fiscal year 1995-96, $24 million and in fiscal year 1996-97, $14 million. An additional $50 million in State bonds was appropriated in 1997 for a Higher Education Technology Infrastructure Fund. Since this money required matching grants from institutions, its total impact will be $100 million in technology spending.

A special task force was formed to address enhancements of educational opportunities through distance learning through a statewide integrated infrastructure that supports voice, video, and data transfers and facilitates joint degrees, partnerships, and flexibility in method of delivery.

Recently, the New Jersey Department of Education (DOE) proposed the Strategic Plan for Systemic Improvement of Education in New Jersey to coordinate the uses of technology in education and information management. The framework includes the following strategies: (1) work with state agencies, professional organizations, higher education institutions, business and industry, and the New Jersey Statewide Systemic Initiative (NJ/SSI) to implement *Educational Technology in New Jersey: A Plan for Action* and the recommendations of the Ad Hoc Council for Technology; (2) make DOE information available online to schools statewide by implementing database, networking, and communications technology at DOE; (3) expand the use of technology to support the public information process, particularly fiscal monitoring and reporting; and (4) continue and expand the ongoing grant program for the establishment of interactive full-motion distance learning sites.

The New Jersey Network (NJN), a founding member and partner with NJDOE in the Satellite Educational Resources Consortium (SERC), is the public television network for New Jersey. NJN offers telecourses for K-12, college, and adult students. Through a partnership with New Jersey colleges, NJN participates in the "Going the Distance" program which allows students to complete 2-year degrees entirely from NJN telecourse broadcasts. NJN also provides the PBS Mathline which includes the Middle School Math Project (MSMP) for professional development of middle-grade math teachers.

DEVELOPMENTS IN OTHER STATES

During the past year, there has been exponential growth in several states' support of advanced technology for delivery of education. ***Wisconsin*** has announced a major program called Technology for Educational Achievement which mandates that $200 million be infused into Wisconsin's universities, technical colleges and elementary and secondary schools, part of it earmarked for teaching educators how to use the technology effectively in and beyond the classroom. The ***University of California at Berkeley*** now offers more than 180 courses over the Internet, the ***State University of New York*** has established the SUNY Learning Network, and ***Pennsylvania State University*** offers courses through the Penn State World Campus..

The Western Governors' Association has founded the ***Western Governors' University***, a degree-granting virtual university, with support from 15 western states and drawing upon the full range of the states' educational institutions. Governor Mike Leavitt of Utah, who has been a leader in this effort, commented recently, "With the Western Governors University, we are creating a global, free market for educational services, delivered to any location at any time. Information and the opportunity to gain knowledge are beginning to flow to where the people are; at home, at work, or on the road."

A MARYLAND EDUCATIONAL NETWORK

For Maryland to compete, a Maryland Educational Network must be created. This Network should be a robust, flexible, high speed digital network serving all postsecondary education and public school systems. Such a network, focusing on the delivery of educational services and products, will provide the basis for achieving the vision enunciated by this Commission. Fairly and equitably, it can provide the statewide connectivity necessary to take advantage of the variety and diversity of all of Maryland's colleges and universities.

Because the rate of innovation and deployment is so rapid and so capital intensive, it is important that the State assist educational institutions in adapting this new technology to their traditional missions. Maryland needs to add information-age services that are beyond what is routinely available from the telecommunications industry and beyond the normal budget capabilities of individual educational institutions. This requires aggressive thought and investment just to stay ahead of states that have traditionally been behind Maryland but that are now making significant strategic investments in information technology in support of their educational systems.

Presently, differences in technologies and technical standards, proprietary hardware and software, and extreme disparities among campuses in information technology resources prevent cooperation and sharing of resources. Certainly Maryland's colleges and universities must be able to access and deliver resources beyond their borders. A statewide educational network should make this possible in a seamless electronic environment, flexibly including data traveling at differing speeds and using varying bandwidth. This will only be possible if the network is not proprietary but is open, based on international telecommunications standards.

In order for the MD Educational Network to provide true state of the art connectivity, an electronic environment must be created that permits the same type of activities to occur between and among campuses as now routinely occur within a campus. Faculty, staff and students who regularly exchange information among themselves within their local campus must be able to do so just as easily and quickly with their peers on other campuses. Few campuses have an affinity group of, say, molecular chemists within the campus, but surely a Maryland Educational Network could identify such a group among all its campuses. Having done so, these chemists must be able to exchange information and knowledge freely as if they were physically together.

The new network architecture must be capable of operating at speeds comparable to that routinely used on campuses. Today, that is 100-155Mbps. Within a short time, operating speeds of one gigabyte per second will be common. Academic resources could then be available to the end-user via his or her network connection, and the resource's physical location may generally not be known to the end-user, local or remote.

A unified telecommunication infrastructure should be able to support integrated data, video and voice. It should link K-12 and higher education and allow both to share their resources with their peers. Long held as an objective during the 1980s, this goal has yet to become a reality. Today, when one looks under the hood of the Maryland educational information technology infrastructure, one generally finds hidden within the wiring closets and the main distribution frames of our buildings different sets of electronic equipment for voice, for data, and for video. The target environment, however, remains the full integration of these forms of information. Technology is finally able to fulfill its promise of integrating these information types into a single switching and transport fabric, within and among educational institutions.

To achieve these goals, the educational network should be based on the "fast packet" technology made possible by Asynchronous Transfer Mode (ATM) and SONET architecture. Instead of the point-to-point leased line technology of the 1970s, 1980s, and early 1990s which operated at fixed speeds, ATM switches will establish connections in whatever amounts of bandwidth are required when needed. Using this technology, combined with appropriate international technical standards, cables providing different bandwidths and speeds can be part of one network; so that the bandwidth can be tailored to the needs of the network participant. Local elementary schools will need less bandwidth than high schools, which will need less than community colleges, which will need less than doctoral-granting research universities. But all should receive the same quality of service, the same speed of access to information, e-mail, teleconferencing, or the Internet.

Specifically, increasing bandwidth under the current architecture involves either striping (adding parallel T-1 circuits for more bandwidth) of existing T-1 point-to-point circuits, or replacing existing 1.544Mbps T-1 circuits with 45Mbps T-3 circuits. The former yields only modest gains in bandwidth; the latter is currently very costly. Furthermore, it would force the Maryland Educational Network to buy more bandwidth than it requires as campuses needs steadily grow. Once bandwidth requirements reach 45Mbps, no path for further growth exists with this option.

Instead of paying for high capacity (presently T-1s) dedicated circuits from one campus to the next, the Maryland Educational Network campus will likely have a single, very high speed, broadband connection from the campus to the nearest point of presence of a public telecommunication vendor. These access channels or local loops, as they have been traditionally called, will begin at DS-3 speeds (45Mbps) and increase to SONET OC-3c (155Mbps) and OC-12 (622Mbps) speeds. With these high capacity but relatively short distance connections into the public telecommunication vendor's cloud, campuses will only bear the cost of this facility between the campus and vendor's local point of presence, not all the way to the next campus. This connection will provide a great deal of functional flexibility including the support of multiple information types (e.g., constant-bit-rate video and voice as well as variable-bit-rate data traffic). Bandwidth to any location beyond the public telecommunication vendor's point of presence can be requested on demand by the campus and provisioned in a matter of minutes or even seconds, and paid for only while in use by the campus.

A SEPARATE EDUCATIONAL NETWORK

The Commission concluded that a separate educational network is needed for several reasons. A network that serves higher education–especially research universities–must be more advanced than networks designed for the general public or for the operations of State government. Whereas dependability and security may be the priority requirements

for a general service telecommunications network; flexibility and speed are the highest priorities for an academic network. Higher education needs to be able to control the allocation of bandwidth because of the great demands for bandwidth inherent in multimedia instruction and advanced research. Experience has also shown that a dedicated educational network with flexibility can be less expensive than a multi-purpose network with varied requirements.

The Commission's proposal for an educational network is modeled on the successful comprehensive educational networks in Georgia (managed by the University of Georgia Board of Regents) and California (managed by the California State University System). Nationally, the Commission did not find any outstanding educational networks which were integrated into a state administrative network. However, there is no reason why an educational network should not be fully compatible with other public networks if the networks share common protocols and technical standards.

A Maryland Educational Network will be able to respond to the needs of education providers and to focus on services to students, faculty, and administrators. It should not be distracted by either commercial ventures (that is, it should not sell services to the general public or to businesses) or by the demands of serving the peculiar needs of State agencies. Special problems unique to higher education are distance learning; extending off-campus student services such as counseling, academic advising, and registration; and access to research materials. A major role of the Network would be to facilitate the development of a "digital library," providing access to the combined library collections of all public colleges and universities and participating independent colleges. These services could be lost or ignored in an omnibus, one-size-fits-all network serving all of State government.

In order for Maryland's postsecondary institutions to effectively (and cost-effectively) take advantage of advanced technologies in instruction, Maryland's high school graduates must be technology literate. Fortunately, this has already been adopted as a goal in the *Maryland Plan for Technology in Education.* Any educational network should provide support to the public schools in achieving the goal of computer literacy. Furthermore, the colleges of education at our public universities must assume responsibility for assuring that newly trained teachers enter the classroom with a knowledge of multimedia instructional techniques and a fundamental understanding of the Internet.

RECOMMENDATIONS

1. The State should fund the design, development, and implementation of a high-speed, broadband, digital Maryland Educational Network, based on international standards and protocols, open to other standards-based networks, to serve all of Maryland public education K-doctorate and independent colleges and universities, and to be available to other independent educational institutions at the lowest feasible cost. The Network should be managed and operated by the University System of Maryland with the control and oversight of the Maryland Educational Network Management Council, which will be broadly representative of all Network users.

2. The Maryland Educational Network should supply Internet access, data connectivity, digital video teleconferencing for instruction, technical consulting services, and other appropriate services to all Network member institutions.

3. The Maryland Educational Network will establish technical standards to which all participating institutions must conform.

4. The Maryland Higher Education Commission, in consultation with the segments of postsecondary education and in cooperation with the Council of Academic Library Directors, should develop a proposal for the creation of a Digital Library to share the resources of all Maryland academic libraries and to permit consortial purchasing of expensive electronic databases.

5. The Maryland Educational Network should make the resources of Maryland postsecondary education available to business, industry and State government through telecommunications. The Network should not be a vendor of telecommunication services but a provider of educational services.

III
ORGANIZATIONAL STRUCTURES

***Governor's Charge**: Recommend any organizational structures needed at the State or institutional level for the effective use of technology.*

MANAGING A STATEWIDE EDUCATIONAL NETWORK

The Commission on Technology in Higher Education heard testimony concerning two of the most successful and comprehensive statewide higher education telecommunications efforts–those in Georgia and California. In both cases, a state telecommunications network for public education K-doctorate is administered by an office within a state university system central administration. A third example of statewide organization which is more decentralized is provided by Florida, which is notable because of its network's board of directors established by State law.

GEORGIA

As described in a previous section, Georgia's telecommunications for higher education are managed by the Office for Information and Instructional Technology (OIIT) of the University System of Georgia. That unit takes a comprehensive approach to its responsibilities. It includes three major divisions: (1) Information Technology, (2) Distance Education and Academic Integration, and (3) Virtual Library, Customer and Information Services. The OIIT employs around 40 professionals. Among the responsibilities of the OIIT are

- operate PeachNet, a statewide computer network providing data transfer, e-mail, and Internet transfer
- plan, develop, and maintain *Galileo*, a virtual library
- coordinate the Georgia Statewide Academic and Medical System (GSAMS), a statewide interactive video instruction and teleconferencing network
- provide technical training and support for users of PeachNet and GSAMS and practitioners of distance education.

The OIIT uses a number of advisory groups to aid it in the coordination planning and development of these several networks. Especially active has been an advisory group consisting of academic library directors which has been primarily responsible for the development of the *Galileo* project.

CALIFORNIA

The California State University network, which serves community colleges and K-12 school districts as well as the CSU campuses, is organized and managed by a unit office of the Chancellor of the CSU System. The Assistant Vice Chancellor for Information Resources and Technology heads an office of around 100 which coordinates a statewide high-speed network, provides support for distance education, is developing a "virtual library," and has organized a "virtual university" to coordinate the distance education offerings of CSU campuses.

The Assistant Vice Chancellor has created several groups to advise him in the conduct of the network. An intersegmental committee on technology applications reports to the California Educational Roundtable comprised of the CEO's of the California State University, the University of California, the California Community Colleges, California independent colleges and universities association, and the State Department of Education. In addition, the CSU has appointed a number of "commissions" to develop policy and to provide oversight on the various telecommunications projects of the CSU System.

DISTANCE LEARNING USERS COUNCIL RECOMMENDATIONS

The Distance Learning Users Council (DLUC) is an advisory council to the Maryland Higher Education Commission. The DLUC presented a matrix to the Commission on Technology in Higher Education which indicated the principles they thought should be followed in establishing the responsibilities for various information technology functions and activities. Because of the comprehensive nature of this matrix and because it identifies the issues which need to be addressed, it is included in the Appendix.

POLICY MAKING AND ADVISORY BODIES

Any management structure developed for the Maryland Educational Network must be sensitive to and representative of the segmental nature of Maryland postsecondary education. The segments are recognized in State law and promote the diversity of education. The several segments are:

The University System of Maryland
The community colleges
Morgan State University
St. Mary's College of Maryland
The independent colleges and universities
The private career schools.

Each segment contains institutions of varying roles and missions, but, as a group, the institutions within each segment share common characteristics that distinguish them and give them particular interests not shared by the other segments. Therefore, the coordination of these diverse interests requires an open and inclusive forum.

Telecommunications may be one of the areas in which all segments do share common needs. Their need for connectivity and efficient access to the Internet are examples. They also have an interest in entering into partnerships. For example, Capitol College has, for several years, been utilizing distance education *via* interactive video to offer the last two years of a bachelor's degree in Electrical Engineering on the campus of Charles County Community College and the last two years of the bachelor's degree in Electronics Engineering Technology at Montgomery College. Similar cooperation occurs between colleges and public schools. For example, Towson University offers advanced placement math courses to Baltimore City and Baltimore County high school students. Capitol College uses MDLN to deliver freshman courses in computers and technology to selected high schools in Prince George's County. An educational consortium in Western Maryland includes Frostburg State University, Allegany, Garrett, and Hagerstown community colleges, and high schools from Garrett, Washington, and Allegany counties.

Testimony presented to the Governor's Commission emphasized the need for a neutral and visionary leadership of an educational network serving all of Maryland education. While the management of the network should reside or be housed within the University System of Maryland because of special expertise and resources, it was felt that a strong oversight was needed to assure the all interests were taken into account.

RECOMMENDATIONS

1. A Maryland Educational Network Management Council should be appointed by the Governor to oversee the design, development, and implementation of the Network. This Council should be composed of 8 presidents of public and independent colleges and universities, 4 representatives of private industry, 2 superintendents of local education agencies, a public school teacher, the Secretary of Higher Education, the State Superintendent of Schools, the Secretary of Health and Mental Hygiene, the Chief of Information Technology, a representative of public broadcasting, and a representative of public libraries. The Council should be chaired by the Secretary of Higher Education.

2. The Management Council will have the power to approve

   a) the Network design;
   b) the development of the Network;
   c) the implementation of the Network; and
   d) the annual budget of the Network.

3. The Management Council will review the guidelines developed by the Maryland Higher Education Commission for all grant funds to be distributed as a part of this initiative.

4. The Maryland Educational Network system operations office within the USM must be sufficiently staffed to provide appropriate leadership to information technology resource development in all of education, K-doctorate. The management operations must be funded at a level competitive with other states with advanced technology networks. The system management office should provide "7x24" staffing (7 days per week, 24 hours per day) of a "help desk" for users of the Network.

5. An information technology clearinghouse, with a primary focus on distance education in Maryland, should be created and maintained by the Maryland Higher Education Commission.

6. The Maryland Educational Network may enter into long-term partnerships with high tech corporations and telecommunications companies for the development of new and marketable technologies and services. Any funds generated by these partnerships accruing to the State should be re-invested in the Network.

IV
THE NEEDS OF INDIVIDUAL INSTITUTIONS

***Governor's Charge**: Identify the future technology needs of individual institutions of higher education and what resources will be needed in order to allow these institutions to fulfill their missions in the next century.*

ESTIMATES OF CAMPUS NEEDS

The needs of the University System of Maryland were presented to the Commission. The need for an educational network connecting all of Maryland public education K-doctorate was emphasized. The University is required to upgrade its present network (UMATS) in order to take advantage of the greater speeds and bandwidth of Internet2. In addition, the University System employees 6,000 faculty members who need (1) training in the use of technology, (2) professional development related to multimedia instruction, and (3) current communication and instructional resources. It was estimated the University could provide training for 5% (300) of its faculty members annually for $3 million additional in operating funds. To upgrade the UMATS network, a one-time expenditure of $3 million is needed. To extend UMATS to all of public higher education and to the public schools is estimated at $22 million. Finally, the University System estimates the cost of technology resources per student to be $300 per year (or $30 million per year for the 100,000 students).

Two recent surveys presented to the Commission identified specific institutional needs for the community colleges and independent colleges and universities - the *Maryland Community Colleges Technology Needs Assessment Survey* (September 1997) and *Technology Needs of Maryland's Independent Colleges and Universities* (February 1998).

The Maryland Community Colleges Technology Council conducted a survey of the 18 community colleges to determine the existing state of campus instructional and administrative technologies and also technology needs for the next five years. Although needs varied by college, all campuses indicated plans to maintain equipment currency, train faculty and staff, construct or retrofit classrooms and laboratories, and employ technical support staff. Requirements to meet college plans over the next five years included: the purchase of over 23,000 personal computers to replace obsolete computers and to meet program growth need, training of over 1,000 full-time faculty in multimedia instructional techniques and 800 faculty in interactive teaching techniques, equipping 400 classrooms for multimedia instruction, and employing an additional 200 technical support staff. The survey also identified standard technology enhancements needed by the community college segment to offer competitive, state of the art instruction including statewide distance learning, statewide data exchange, electronic classrooms, campus telecommunications infrastructure and switching equipment, and broad-band Internet access. To address all of these needs would cost around $100 million.

The Maryland Independent College and University Association (MICUA) conducted a survey of technology needs of its 15 member institutions. Campuses indicated current resources and projected institutional needs through the year 2003. The institutions identified four predominant technology issues: support for instructional technologies; training and support for faculty, staff and students; upgrading, maintaining and expanding the campus network; and ensuring funding to maintain and upgrade hardware and software, and to expand and upgrade technology throughout the campus.

The MICUA institutions are spending annually more than $50 million for on-going information technology activities and, in FY 1997, spent approximately $20 million additionally on one-time capital expenditures for technology. Despite this commitment, projected needs for the segment over the next five years include: 9,340 personal computers to replace computers with current technology (defined as a Pentium-133 or faster processor), increased bandwidth from the campus to the Internet for five institutions and increased speed at nine institutions, 248 additional distance learning and multimedia classrooms, training for over 2,000 full and part-time faculty in multimedia and distance learning techniques, 243 new positions for instructional and administrative technology support staff, and administrative systems software replacements. Adding all of the independent colleges and universities needs together, it would take $102.4 million to overcome the campuses reported deficiencies.

It should be noted that both the Community College survey and the MICUA survey covered all technology needs on a campus, including normal operational equipment. Much of the technology requirements included in their needs assessment are items which should be accommodated within normal operating budgets. This Commission has focused on issues of statewide connectivity and enhancements required for institutions to take advantage of statewide connectivity.

WHAT IS THE FUNDING FOR?

Taken together the two surveys discussed above indicate the types of resources that are needed on campuses to take advantage of advanced technologies. Presently, neither operating nor capital budgets provide adequate funds to cover investments of the scope required. Even with the 1996 community college formula funding enhancements, the community colleges' operating budgets will not be able to absorb costs of the magnitude required both to provide the additional investments needed to become fully active players in the Information Age and to periodically renew that investment to maintain state-of-the-art competitiveness.

LARGE INITIAL INVESTMENT COST

A single electronic classroom equipped to permit use of multimedia software currently available from major book publishing firms can cost in excess of $100,000. A single compressed video teleconferencing lab costs from $50,000 to $130,000, without considering the infrastructure improvements to inter- and intra-building cabling that are required to deliver a telecommunicated signal to the lab.

NEW OPERATING AND MAINTENANCE COSTS

Once installed, information age technology poses a substantial new burden on the operating budget. Line costs, toll charges, LATA fees, maintenance contracts, repair and replacement parts, and the costs of technicians to maintain the new systems will all consume a significant portion of a college's operating budget.

HIGH CYCLICAL RENEWAL COST

In addition to catching up and maintaining this new technology, the colleges must make significant recurring investments to renew the technology in order to sustain currency with the state of the art. New, expanded investments in technology add to the scope of these cyclical renewal costs. Every five years or less, desktop computing equipment must be upgraded or replaced to provide students with the training on up-to-date equipment required by business and industry. These "new technology" cyclical renewal expenses – occurring in a period of steady or declining enrollments, added to the computer lab upgrades colleges have been struggling to fund in recent years – place a burden on operating budgets of a magnitude rarely experienced by colleges and universities.

TECHNICIANS AND STAFF DEVELOPMENT

Two additional significant costs are also growing: those required to keep faculty and staff current in the use of these new technologies, and requirements for additional employees to operate and manage new systems. Colleges will not become transformed to information age learning institutions without making a substantial additional investment in faculty and staff professional development and training. Information age technologies require network administrators, video technicians, lab aides and technicians with specialized knowledge and skills. These new training and staffing costs will test the budget resources of the wealthiest institutions. College operating budgets are already struggling to maintain existing computer labs in a current state of the technology. Without special funding help to cover some of these costs, our colleges and universities will not make substantial progress in becoming front line institutions serving Maryland's business and industry community.

REGULATORY BARRIERS

Institutional needs are not restricted to the funding and expansion of infrastructure, equipment, and training, but also include the need for State policies and regulations that support the transformation of instruction to incorporate and integrate new technologies. The demands of consumers of higher education coupled with the capability of technology to transcend geographic and political boundaries have created a need for public policy changes to reduce regulatory barriers which inhibit a response to the market, while retaining a state role in the regulation and coordination of higher education for access, quality, and efficiency. In the present higher education environment, state agencies can best support institutions through policies and activities that leverage partnerships, coordinate program development, invest in programs that meet statewide goals, and ensure that institutions are competitive and serve well the residents of the state. Regulatory reforms should seek to deregulate intrastate electronic delivery, support institutions operating on a national and international basis, increase consumer information functions, and use program approval authority to expand the availability of electronic offerings and inter-institutional cooperation.

Recognizing the explosion of distance education and multimedia approaches to instruction, the Maryland Higher Education Commission already has initiated significant policy changes to remove regulatory barriers to distance education. Recent amendments to the *Minimum Requirements for Degree-Granting Institutions* concerning distance education remove requirements for "immediate live" instruction while maintaining requirements for "regular interaction" between student and instructor. The regulations additionally assure that quality of instruction is maintained by requiring institutions to provide evidence of compliance with proscribed "standards of good practice". These "best practices" are advocated by the Western Interstate Consortium of Higher Education, the Middle States Association of Schools and Colleges, and by the Southern Regional Education Board.

Additional regulatory issues recognized as potential barriers to the expanded use of distance education include State regulations guiding out-of-county tuition differentials, definitions restricting inclusion of technology resources and equipment as capital expenditures, and federal regulations restricting eligibility for student financial aid. There is also concern that the Federal de-regulation of telecommunication carriers still has not removed the barriers to local carriers (such as allowing Bell Atlantic-Maryland to enter into long distance). The Maryland Higher Education Commission should continue its role of reviewing State and Federal educational regulations for currency in an evolving technological environment

RECOMMENDATIONS

1. Each college and university campus should make certain defined baseline information technology resources and capabilities available to all students, faculty and staff. The State should fund a matching grant program, administered by the Maryland Higher Education Commission, to aid institutions in achieving these baseline standards for resources. The baseline standards should be developed by the institutions through the Educational Technology Policy Council and approved by the Maryland Higher Education Commission , in consultation with the management of the Network.

    a) Operating funds should be appropriated to aid in the one-time expenditure for campus infrastructure, including wide area networks and local area networks to allow campuses to achieve the baseline level of services.

    b) State matching grant funds should be available to aid in the purchase of equipment, hardware, and software needed for classroom instruction, laboratories, and other academic purposes to achieve the minimum level of resources.

c) The Maryland Higher Education Commission should monitor the use of these funds to assure that baseline levels of resources and services are achieved.

d) In order to qualify for these funds, a campus must have a technology plan approved by its governing board and by the Maryland Higher Education Commission.

2. The State should fund a competitive matching grant program, administered by the Maryland Higher Education Commission, for public and independent colleges and universities to support the development of institutional information technology resources when these can be shown to be compatible with the Maryland Educational Network proposed by this Commission. Preference should be given to projects which include

   a) a public-private partnership;
   b) innovative uses of technology;
   c) responses to identified workforce training needs; and
   d) renewing technology resources.

   In order to qualify for these funds, a campus must have a technology plan approved by its governing board and by the Maryland Higher Education Commission.

3. The State should make technology equipment and infrastructure expenditures associated with new capital construction or the renovation of academic buildings eligible for State funding. Any policy adopted must recognize the rapid depreciation of information technology resources.

4. The Maryland Higher Education Commission should expedite a study of the future need for the construction of additional classroom space on existing campuses in light of the impact of distance education.

5. The Maryland Higher Education Commission, in consultation with the segments of postsecondary education and the Educational Technology Policy Council, should review State laws and regulations to identify and repeal unnecessary regulatory barriers to the expanded use of distance education, so long as that instruction conforms to accepted standards of quality.

V
TOMORROW'S WORKFORCE

***Governor's Charge**: Evaluate the nature of the jobs of the future and the technology resources necessary both to prepare students for the future workplace and the faculty that will be responsible for that preparation.*

NATIONAL TRENDS

The sweep of digital technologies and the transformation to a knowledge-based economy have created a robust demand for workers highly skilled in the use of information technology. In the past ten years alone, employment in the U.S. computer and software industries has almost tripled. The demand for workers who can create, apply and use information technology goes beyond these industries, cutting across manufacturing and services, transportation, health care education and government.

Having led the world into the Information Age, there is substantial evidence that the United States is having trouble keeping up with the demand for new information technology workers. A recent survey of mid- and large-size U.S. companies by the Information Technology Association of America (ITAA) concluded that there are about 190,000 unfilled information technology (IT) jobs in the United States today due to a shortage of qualified workers. In another study, conducted by Coopers and Lybrand, nearly half the CEOs of America's fastest growing companies reported that they had inadequate numbers of information technology workers to staff their operations.

Job growth in information technology fields now exceeds the production of talent. Between 1994 and 2005, more than a million new computer scientists and engineers, systems analysts, and computer programmers will be required in the United States – an average of 95,000 per year. One difficulty is that the formal, four-year education system is producing a small proportion of the workers required. Only 24,553 U.S. students earned bachelor's degrees in computer and information sciences in 1994. While many IT workers acquire the needed skills through less formal training paths, it is difficult to determine whether such training can be adequately expanded to meet the demand for IT skills.

GLOBAL IMPACT

This shortage of IT workers is not confined within the borders of the United States. Other studies, including work by the Stanford Computer Industry Project, document that there is a world wide shortage of IT workers. That industries in other nations are facing similar

Table 2. The 10 Occupations with the Fastest Employment Growth Nationally, 1996 - 2006

(Number in thousands)

Occupation	Employment		Change, 1996- 2006	
	1996	2006	Number	Percent
Database Administrators, Computer Support Specialists, and all other Computer Scientists	**212**	**461**	**249**	**118**
Computer Engineers	**216**	**451**	**235**	**109**
Systems Analysis	**506**	**1,025**	**520**	**103**
Personal and Home Care Aides	202	374	171	85
Physical and Corrective Therapy Assistants and Aides	84	151	66	79
Home Health Aides	495	873	378	76
Medical Assistants	225	391	166	74
Desktop Publishing Specialists	**30**	**53**	**22**	**74**
Physical Therapists	115	196	81	71
Occupational Therapy Assistants and Aides	16	26	11	69

Source: Bureau of Labor Statistics *News* (December 1997) problems exacerbates the U.S. problem since the geographic location of such workers is of decreasing importance to the conduct of the work. U.S. employers will face tough competition from employers around the world in a tight global IT labor pool. Thus, the United States cannot expect to meet its long-term needs through increased immigration or foreign outsourcing, and must rely on retaining and updating the skills of today's IT workers as well as educating and training new ones. Failure to meet the growing demand for IT professionals could have severe consequences for America's competitiveness, economic growth, and job creation.

To assess future U.S. demand for IT workers, the Office of Technology Policy analyzed Bureau of Labor Statistics' (BLS) growth projections for the three core occupational classifications of IT workers: computer scientists and engineers, systems analysts, and computer programmers. BLS projections for occupational growth are given in three bands-low, moderate, and high. The following analysis uses the moderate growth figures.

BLS projections indicate that between 1994 and 2005, the United States will require more than one million new IT workers in these three occupations to fill newly created jobs (820,000) and to replace workers who are leaving these fields (227,000) as a result of retirement, change of professions, or other reasons.

Of the three occupations, the largest job growth is accounted for by systems analysts, which are projected to increase from 483,000 in 1994 to 928,000 in 2005, a 92 percent jump. This compares to a projected increase of 14.5 percent for all occupations. The number of computer engineers and scientists is expected to grow by 90 percent, from 345,000 to 655,000 over the same period, while the number of computer programmer positions is expected to grow at a much slower 12 percent rate, from 537,000 in 1994 to 601,000 in 2005. However, while only 65,000 new computer programmer jobs are projected to be created during this period, 163,000 new programmers will be required to replace those exiting the occupation.

IMPACT ON MARYLAND

The workforce needs of Maryland employers are impacted by availability, changing technology, and an ability to retain and attract the best and the brightest, particularly with the concentration of talent and technology along the I-270 Corridor.

The availability of workers with appropriate skills is a critical success factor in the growth of any business. Maryland should position itself as a state with a "ready-made" workforce prepared to enter the growth industry sector companies well-trained in both fundamentals and specialties. This will involve education and training for important jobs at all degree levels; high school, associate, bachelor, master and doctoral as well as certificates of skills competencies.

The growth of Maryland's high-tech industry companies is being hampered by a shortage of qualified employees. This is a common problem that Maryland shares with competitor states – demand is far outstripping supply. The problem extends to all levels of employment, from entry level technicians with high school diplomas to freshly minted college and graduate trained professionals to experienced mid-level professionals. Not enough graduates are being generated within the region, and experienced scientists and engineers are the objects of intense competition.

By the year 2005, Maryland's economy is expected to add an estimated 475,000 new jobs. Growth is expected to favor service-producing industries where about nine out of every ten new jobs will be created. Within the service economy, the services and retail trade industries will be the major catalysts for growth.

Growth in Maryland jobs, as nationally, will be led by growth in technology -related fields. Table 3 shows the projected growth of technology-related occupations to 2005 in Maryland. Technology-related jobs will account for two-thirds of all openings resulting from growth and separations during the period. And among the fastest growing jobs will be systems analysis and computer science, data processing equipment repair, computer and mathematical occupations, and operations and research analysis.

In addition to the need for "new hires," there is a strong demand for sophisticated IT education and training for the workforce in place, and for professionals who are concerned with acquiring and keeping current their IT skills. To address these immediate short- term needs, there is a need to focus on developing education and training programs for students at the Bachelor's, Master's and doctoral levels in IT, and on creating a rich menu of course offerings in degree and non-degree programs, offered on and off campus, directly responsive to specifically identified corporate needs.

PRODUCING GRADUATES IN TECHNOLOGY FIELDS

For several legislative sessions, the Governor and the General Assembly have shown their support for increasing the number of college graduates in high technology fields. Notable initiatives have included the *Science and Technology Scholarships*, which will provide full tuition and fee support for students majoring in technology-related fields as long as those students maintain good academic standing, and the *Maryland Applied Information Technology Initiative* (MAITI). This consortium of seven universities has as its goal a doubling of the number of students enrolled in and graduated from information technology programs by the year 2003. The Commission applauds and supports both of these programs.

MAITI ultimately plans to embrace all of higher education, the K-12 sector, state and local governments, and the IT industry. Increases in IT graduates will come from increased enrollments in computer science, the decision and information sciences majors in business, and engineering. MAITI will also work with other higher education institutions with significant IT programs and with the community colleges to achieve a similar growth in IT graduates from those institutions.

EDUCATING A HIGH TECHNOLOGY WORKFORCE

The Commission on Technology in Higher Education believes that, if a broad base of technology workers is to be created, change must occur in the fundamental nature of instruction in colleges and universities. In fact, this change has begun, but it is inhibited by both the strength of traditions and a lack of resources and funding. Maryland's future

Table 3
Maryland Occupational Distribution of Employment
1992 - 2005
For Occupations Related to Electronics and Computing

Occupational Titles	Employment 1992	Employment 2005	Percent Change	Openings Growth	Openings Separation	Total
Total, All Occupations	2,174,919	2,649,797	21.83	474,878	599,352	1,074,307
Executive, Admin, & Managerial Occupations*	174,340	223,471	28.18	49,131	36,426	85,553
Engineering, Mathematical & Nat. Science Mgrs.	9,053	12,125	33.93	3,072	1,833	4,901
Communications, Transp, Utils Oper. Mgrs.	1,784	2,204	23.54	420	364	780
Professional, Paraprofessional & Technical	481,620	627,332	30.25	145,712	106,626	252,395
Electrical & Electronic Engineers	13,365	17,735	32.70	4,370	3,653	8,021
Electrical & Electronic Technicians	10,023	14,295	42.62	4,272	1,573	5,850
Computer and Mathematical Occupations	35,849	55,090	53.67	19,241	6,682	25,922
Computer and Related Occupations	30,348	48,552	59.98	18,204	5,772	23,985
Systems Analysis & Computer Science	15,839	27,416	73.09	11,577	1,638	13,221
Computer Programmers & Aides	14,432	21,050	45.86	6,618	4,108	10,725
Programmers: Numerical, Tool	77	86	11.69	9	26	39
Comp., Math, Scientists & Oper. Res Anals.	5,501	6,538	18.85	1,037	910	1,937
Operations and Research Analysts	2,343	3,545	51.30	1,202	377	1,573
Administrative Support Occupations, Clerical	408,583	453,988	11.11	45,405	102,063	147,459
Electronic Data Proc. & Office Machine Occps	23,159	26,051	12.49	3,892	5,278	8,177
Computer Operators, Excl Peripheral	6,712	7,322	9.09	610	728	1,339
Peripheral EDP Equipment Operators	439	474	7.97	35	52	91
Communications Equipment Operators	6,373	4,652	-27	-1,721	2,132	2,132

Table 3 (continued)

Occupational Titles	Employment 1992	Employment 2005	Percent Change	Openings Growth	Openings Separation	Total
Precision Production, Craft & Repair Occs.	22,794	264,005	18.5	-41,211	63,128	104,351
Communication Equipment Mechanics	1,981	1,213	-38.77	-768	416	416
Central Office & PBX Installers & Repairers	1,179	698	-40.80	-481	247	247
Frame Wires, Central Office	26	21	-19.23	-5	-	-
Signal of Track Switch Maintenance Workers	34	32	-5.88	-2	13	13
Radio Mechanics	46	43	-6.52	-3	13	13
All Other Communications Equip Mechanics	696	419	-39.8	-277	143	143
Electrical & Electronic Equipment	11,018	11,853	7.58	835	2,912	3,757
Telephone & Cable Installers & Repairers	3,056	2,015	-34.06	-1,041	832	832
Data Processing Equipment Repairers	1,594	2,654	66.50	1,060	183	1,248
Electronic Repairs, Commercial & Industrial	2,278	2,682	17.73	404	494	897
All Other Electrical & Electronic Equip Mechs.	645	661	2.48	16	182	195
Electrical Powerline Installers & Repairers	1,570	1,869	19.04	299	611	910
Electromedical & Biomedical Equip Repairers	96	132	37.5	36	13	52
Electrical Workers	10,381	13,307	28.19	2,962	2,938	5,863
Electricians	10,381	13,307	28.19	2,962	2,938	5,863
Electronic Pagination System	151	187	23.84	36	52	91

Source: Maryland Department of Economic and Employment Development, *Jobs 1992 - 2005* (September 1994).

* Shading indicates a summary category.

work environment will require a new Maryland workforce. In turn, this will require a transformation of the instructional model in education. The use of multimedia and distributed technologies provides both the opportunity for flexible distance learning not bound by time or place and an enhanced traditional classroom. The new classroom is a global learning environment which is student-centered rather than campus-centered, virtual rather than defined by a physical location, and is composed of an array of educational services offered by multiple providers through multiple technologies. The new learning model is nonlinear, structured according to learner needs. Students access learning through the Internet, cable, and satellite technologies, or they enter a learning "classroom" of individual stations to learn specific topics and demonstrate competencies. Access becomes the critical issue in higher education. Access means the availability of courses and training at convenient times and locations and through flexible formats. It means varied options for combining and documenting learning outcomes for the awards of degrees. It means availability of information and experts outside the walls of a single institution. The new learning environment crosses institutional, state, and national boundaries.

Three factors change in the new instructional model: the concepts of time and place and the role of the instructor. Time to complete a learning activity may expand or contract to fit the learner's preparation and goals. Place may be extended to the virtual classroom. The instructor becomes the facilitator and creator of the learning environment and not the sole information source. This significant change in the role of the instructor necessitates attention to faculty training and development.

The computer- and technology-dependent society requires that students graduate with the technology-related skills necessary to be effective in the workplace. To ensure that all learners, K-12 through higher education and beyond, understand and use current technologies to access information and communications resources in a variety of settings, current college faculty and teacher education candidates must be proficient in basic computer skills and the use of multimedia as an integral part of instruction. The new learning environment requires that faculty become not only content experts, but competent in instructional design, application design, and technical implementation. In addition to technical capability in using and applying new technologies, competencies in new instructional techniques such as designing curricula based on student learning needs; and accessing information and experts over the Internet are required. In order to support the faculty in the transformation of the instructional model, a redefinition of a faculty member's teaching and research responsibilities is needed that accounts for the time required to develop and maintain technological proficiency for effective teaching.

Colleges and universities will need to provide incentives for the majority of faculty members to encourage them to embrace multimedia instruction. If a faculty member develops the syllabus, assigned readings and exams for an online course that will then be offered by other faculty members or may be marketed nationally by his/her university, the faculty member must be assured of an appropriate compensation. Otherwise, the faculty member may not be willing to devote the time to acquiring the training and skills needed to develop an online course.

Both the Maryland Higher Education Commission's *Teacher Education Task Force Report* and the Blue Ribbon Committee on Technology in Education's *Maryland Plan for Technology in Education* recognize 1) the improvements needed in campus-based technologies and distance learning capabilities and 2) the necessity for ongoing professional development training, including support for faculty to use technology and to design instructional programs that integrate technology into the learning environment. The requirements for a technologically trained workforce extend both to the preparation of students for the future workplace and of the faculty responsible for the students' education.

In order to assure that Maryland's college graduates are prepared for a high technology workforce, the State should take steps to insure that all students graduating from public colleges and universities have acquired at least a minimum level of technology skills. This assumes that all public institutions of higher education will attain a baseline level of information technology resources.

RECOMMENDATIONS

1. In order to assure that Maryland high school graduates will enter college with technology skills and to assure that adequate teacher training is required, by the year 2003,

   (a) graduates of public high schools should be computer literate;
   (b) faculty in teacher education programs should be required to demonstrate basic computer skills and an ability to incorporate multimedia into instruction; and
   (c) in order to be certified to teach in Maryland, prospective teachers should be able to demonstrate basic computer skills and the ability to use computers in multimedia instruction.

2. Every student in a public college or university should be competent in the use of computers and basic computer software – word-processing, spread sheets, and graphics – by the end of the sophomore year (or the completion of 60 credit hours).

3. Each classroom and instructional space in a college or university should be wired to permit multimedia instruction at a defined baseline level. The Maryland Higher Education Commission, in cooperation with the Department of Budget and Management, and in consultation with the Education Technology Policy Council, should develop the baseline requirements for information technology capabilities for instructional spaces.

4. The State should fund a 5-year competitive matching grant program, administered by the Maryland Higher Education Commission, to support faculty training and continuing professional development to encourage the design and use of multimedia instruction and distance learning applications. Consideration should be given in making these grants to projects that will benefit students of all institutions in the State. The products of these grants should be shared with all institutions in the State.

   In order to qualify for these funds, a campus must have a technology plan approved by its governing board and by the Maryland Higher Education Commission.

VI
FUNDING

***Governor's Charge**: Recommend the appropriate amounts of State expenditures in providing the funding needed to meet these future needs, as well as the appropriate roles of the State and higher education institutions in funding for hardware and software resources, ongoing maintenance, and telecommunications infrastructure in capital projects.*

GENERAL OVERVIEW

Technology plays a more significant role in higher education than ever before. In most cases, funding for technology has been *in addition to* existing operating costs. College administrators have generally recognized the importance of telecommunications and technology in the academic life of their students, but they have difficulty funding the development of technology infrastructure and the installation of basic systems or upgraded systems for distance learning and Internet services. Across the nation, states have used a variety of methods to fund their investments in technology. This chapter explores those methods.

To the present, the State of Maryland has had no funds specifically targeted at information technology for higher education. The State has adopted as a first priority the networking of the public schools and bringing those schools up to a minimum level of technology resources. To this end, the State has enacted the **Technology in Maryland Schools Program,** a 5-year commitment of close to $62 million to build the technology infrastructure and capacity of approximately 700 public schools. This program provides each school with complete wiring for voice, video and data; it also provides funds for computer workstations, software, and professional development. No similar overall approach to funding technology resources in higher education has been undertaken.

Recent data collected by the Maryland State Department of Education and the Interagency Committee on School Construction show a need to fund approximately 528 additional public schools beyond the 700 originally included. Therefore, it has been proposed that the Technology in Maryland Schools be extended and accelerated to wire all schools by the year 2003, a two-year extension of the Program. The Commission on Technology in Higher Education supports this extension and expansion.

However, the funds under this program can only be expended to cover individual school buildings. Costs to connect these schools to their central office or to connect to a larger statewide network cannot be provided under the current program funding structure. Since it is the goal of the Commission on Technology in Higher Education to create a comprehensive statewide education network, this Commission would strongly urge the Governor and the General Assembly to provide for alternative funding within the Technology for Maryland Schools Program to complete this network through the inclusion of the central offices in each school district, which would provide the link to the Maryland Education Network advocated here. It is estimated that this would require approximately $270,000 per school district, for a total of $6.5 million.

FUNDING APPROACHES

Allocations for higher education information technology show considerable diversity. Some states reveal little or no allocation, while other states show remarkable sums being devoted to technology. New Jersey, for example, has approved bonds valued at $50 million for technology in higher education ($100 million with the required matching funds). Virginia has dedicated $74 million to statewide connectivity.

In some states, such as Colorado, Georgia, and Iowa, the legislature directs technology funds to the state higher education system, commission, board of regents, or a technology task force for distribution to institutions. Other states, like Oregon and Kansas, have a more decentralized method: The legislature in those states distributes all operating funds, including technology funds, directly to the local institutions of higher education.

Most money for information technology comes to the institution via an allocation from the state general fund. Nevertheless, sources other than general fund allocations are also of interest. Knowing that higher education benefits from other funding sources such as a lottery or bonds, legislators are sometimes frugal in their allocations.

LEGISLATIVE ALLOCATIONS

These monies are made annually or biannually, depending on the state's budget cycle. In a few states the allocations are more sporadic or even one-time-only events. Typically, the legislature allocates funding to the state higher education agency, which in turn distributes to the colleges and universities, either on a per-student basis or through competitive grants or on the basis of a completed technology plan. The technology plan is important because it assures that institutions have considered all of the educational and technology planning system requirements.

Examples of legislative allocations could be found in many states across the nation. In Ohio, for example, the legislature made an allocation of $12,003,243 in 1995-96 from the state general revenue fund to support information and educational technology initiatives in higher education. Pennsylvania's governor has made a special case to the legislature for an allocation of $21 million over three years to higher education institutions to facilitate the planning and implementation of the Pennsylvania Education Network (PEN), an advanced computer and telecommunication system.

BONDS

Instead of dipping into the state's general fund for technology monies, a few states establish bond funds. Bond funds are typically distributed through the state education agency or the department of information technology. Because bonds tend to be longer term, they are not often used for the acquisition of technology premises equipment, but rather for communications and network transport.

Examples of bond fund use include: Virginia, where the state has approved a bond of $10 million for improvement of access to campus networks and Internet for students and faculty; Washington, where colleges and universities had received $15.3 million from a state issued bond to improve access to learning resources through interconnectivity among all users of telecommunication resources; and New Jersey, where a $50 bond fund was created to support a matching grant program, raising the total impact to $100 million.

DESIGNATED TAXES

Special dedicated taxes have been established by legislatures to acquire funding for educational telecommunications. At present, only one state, Missouri, has such a tax - on videotape rentals - dedicated to education, specifically to video telecommunications. These monies are used for grants to public school districts, public institutions of higher education, and public television stations for equipment and instruction. Alaska also has a tax on oil drilling, but those oil royalties are directed to the general fund, not just to technology.

LOTTERIES

Widely viewed as a painless way to capture monies for designated purposes, many state legislatures have used the lottery as a means of funding education. Such states as Florida and Georgia, rely on the lottery to fund educational technology. The designation of lottery profits to educational technology requires a legislative act. Within states, lottery income varies from year to year.

CAPITAL FUNDS AND GRANTS

Capital construction projects and grant funding have offered the chief vehicles through which some colleges have made progress in transforming their campuses to information-age readiness. But these fund sources each have serious limitations. Soft money is available only sporadically, often is targeted on very specific programmatic goals, and tends to continue for only a few years. The nature of the new information technology is pervasive, interconnected, and systemic. Funding support for major technology enhancements needs to be *reliable. applicable to campus-wide systems, timely, and ongoing.*

The Maryland capital budget process for colleges is not presently structured to address these needs. Further, the capital funding process focuses on new construction of buildings and largely overlooks the transformational role that information technology will play in re-defining how colleges deliver learning and interact with students. Specifically, interpretation of guidelines for eligible capital purchases excludes many information technology system components. Furthermore, capital bonds can only be used for capital purchases with an expected life of at least 15 years. Computers and related equipment normally have a life-expectancy of 4-5 years or less.

FUNDING ALLOCATION COMPARISON FOR HIGHER EDUCATION TECHNOLOGY

The Commission on Technology in Higher Education reviewed a recent study of *State Funding for Higher Education Technology, 1995-1997* prepared for the State Higher Education Officers Organization (SHEEO) by Hezel Associates. Dr. Richard Hezel also appeared before the Commission. Table 4 (page 46) compares the funding of technology in higher education in several states and in Maryland for this two-year period.

FUNDING FOR THE MARYLAND EDUCATIONAL NETWORK

The Commission is recommending four funding initiatives to support the development and implementation of the Maryland Educational Network and to promote the competitiveness of Maryland's postsecondary education system in the information technology arena. The Commission recognizes that trying to project costs of rapidly changing technologies is perilous at best. The recommended amounts, therefore, can be seen only as informed projections, subject to subsequent review and adjustment.

In developing its recommendations for funding, the Commission was guided by several premises:

1. The highest priority for the State is the creation of a statewide educational network.

2. All public educational institutions – colleges, universities, and public school systems – and independent colleges and universities must be brought to a level at which they can have access to and benefit from the statewide network.

3. The State should not assume the financial burden for normal operating expenses which are common to all institutions – such as the purchase of office equipment or normal ongoing faculty development, but should focus primarily on one-time funding to develop institutional capabilities – such as the installation of local area networks and the creation of multimedia instructional training centers.

4. State grant funds should not be used to substitute for institutional operating budget funds in the purchase of information technology resources.

5. In order to qualify for participation in any of the funding recommended by this Commission, an institution must have a technology plan which indicates institutional commitment to multimedia instruction.

The design, development and implementation of the Network will require $94.3 million over five years. This will be a scaleable Network – growing in capacity as use grows, with any expansion justified by the usage generated. The commitment of State funds would be approximately $20 million annually for the next five years, declining from a first-year commitment of $23.54 million to $16.04 million in the fifth year.

Table 4
State Expenditures for Technology in Higher Education:
Maryland and Selected States, 1995-1997

STATE	PROJECT NAME	LEGISLATIVE REFERENCE	FUND AMOUNT	NUMBER OF YEARS	EXPECTED FUTURE FUNDS
Maryland	Maryland Information Technology Investment Fund	none	$4 million	1	$10 million for equipment
Georgia	Georgia Library Learning Online	Annual Appropriations	$18.3 million	3	$3 million for building of model classrooms.
	Connecting Teachers and Technology		$17.8 million	2	
	Connecting Students and Services		$7.2 million	2	
New Jersey	Equipment Leasing Program	P.L. 1993, c.136 P.L. 1996, c.42	$100 million	7	
Ohio	OhioLink Library Access	Bill 117	$5.9 million	increases annually	$9.3 million
	Ohio Super Computer Center		$3.6 million		$10.8 million
	Information Systems		$2 million		$3.8 million
	Center for Artificial Intelligence		$448,187		$459,392
Pennsylvania	Link to Learn Project	HB837 (P.N.3930)	$21 million	3	$7 million
Virginia	Higher Education Technology Initiative	Appropriation Act	$74.0 million	2	

FOUR CATEGORIES OF FUNDS

The creation of the **Maryland Educational Network** will require $24.7 million over five years. This will include $17 million in direct operational funding to the USM for the statewide network or "backbone." It will include another $7.7 million to pay for the membership in the Network of public colleges and universities, independent colleges and universities, and 24 public K-12 school boards.

The remainder of the funds recommended will be used to bring individual colleges and universities to a level of technology preparedness so they can benefit from the Network. The Commission is recommending three matching grant funds. The first, the **Baseline Resources Grant Program,** ($31.6 million over 5 years) will be for colleges and universities which have not yet achieved a specified baseline level of information technology resources. There will be two uses for these grants: (a) to support the development of campus infrastructure necessary to connect to and distribute the statewide network on campus (e.g., network compatible routers and servers, LANS, and basic infrastructure): and (b) to support the purchase of hardware and software to upgrade information technology resources adequately to benefit from the network.

The Baseline Resources Grant Program assumes that baseline level standards for IT resources will be developed by the Maryland Higher Education Commission in consultation with appropriate interests, especially the management of the Maryland Educational Network. The need for such funding will be greatest in the early years of the program and will diminish as campuses attain the established baseline level of resources. Funds from this program will be distributed competitively according to need. To be eligible, campuses will be required to submit a telecommunications plan that clearly indicates the institution's commitment of resources to information technology expenditures. It is recommended that institutions be required to have a 20% match for State funds received under this program.

The second grant program will be the **Innovative Projects Grant Program** ($16 million over 5 years). This program will fund projects proposed by institutions that have already attained and/or surpassed the minimum level of IT resources. Institutions could not qualify for both grant programs during the same year.

The Innovative Projects Grant Program will support public-private partnerships, innovative uses of technology, responses to identified workforce training needs, and the renewal of technology resources. It is assumed the capabilities of institutions to develop such programs will increase as more institutions attain the baseline standards for IT resources. It is recommended that institutions have a 40% match for State funds received under this program.

A **Faculty Training and Professional Development Program** ($22 million over 5 years) is recommended by the Commission in the recognition that expenditures on hardware are wasted if faculty and staff are not eager and proficient users of information technology. One focus of this program will be the development of institutional capabilities to provide faculty training through the establishment of training centers, offices, and institutes. A second focus of the program should be to provide (a) faculty incentives for the development of new courses and curricula, (b) equipment needed for multi-media instructional training, and (c) direct faculty training and professional development support. The need for these funds should decrease as institutions complete their developmental projects and assume support for those activities in their operating budgets. It is recommended that institutions have a 40% match for State funds received under this program.

The State may wish to consider funding these grant programs through a special bond issue – a mechanism used in New Jersey. The intent is to fund major one-time installations of LANs and WANs and necessary facility upgrades to lay the foundation for advanced connectivity. After this initial "jump start," institutions must assume responsibility for remaining current by reallocations of resources, creating new revenues through technology fees, and other means.

In seeking revenues to support information technology initiatives, the State needs to maximize its efforts to obtain Federal funds for these purposes.

SUMMARY OF FUNDING RECOMMENDATIONS, FY 2000--FY 2004
(in millions)

1. **Maryland Educational Network:** The State should fund the design, development, and implementation of a high-speed, broadband, digital Maryland Educational Network, based on international standards and protocols, open to other standards-based networks, to serve all of Maryland public education K-doctorate and independent colleges and universities, and to be available to other independent educational institutions at the lowest feasible cost. The Network should be managed and operated by the University System of Maryland under the control and oversight of the Maryland Educational Network Management Council, which will be broadly representative of all network users. $24.7M

2. **Baseline Resources Grant Program:** Each college and university campus should make certain defined baseline information technology resources and capabilities available to all students, faculty and staff. State funding should be available to aid these institutions in achieving these baseline standards for resources. The baseline standards should be developed by the institutions through the Educational Technology Policy Council and approved by the Maryland Higher Education Commission.

   a) Funds should be appropriated to aid in the one-time expenditure for campus infrastructure, including wide area networks and local area networks to allow campuses to achieve the baseline level of services. $7.1M
   b) State matching grant funds should be available to aid in the purchase of hardware and software needed for classroom instruction, laboratories, and other academic purposes to achieve the baseline level of resources. $24.5M

c) The Maryland Higher Education Commission must monitor the use of these funds to assure that baseline levels of resources and services are achieved.

In order to qualify for these funds, a campus must have a technology plan approved by its governing board and by the Maryland Higher Education Commission.

3. **Innovative Projects Grant Program:** The State should fund a competitive matching grant program for colleges and universities to support the development of institutional information technology resources when these can be shown to be compatible with the Maryland Educational Network. This program should be supported by State funding, either capital or operating. The funding level should be competitive with similar programs in other states with advanced technology networks. Preference should be given to projects which include

   a) a public-private partnership;
   b) innovative uses of technology;
   c) responses to identified workforce training needs; and
   d) renewing technology resources.

   In order to qualify for these funds, a campus must have a technology plan approved by its governing board and by the Maryland Higher Education Commission. $16M

4. **Faculty Training and Professional Development Program:** The State should fund a 5-year competitive matching grant program to support to encourage the design and use of multimedia instruction and distance learning applications. Consideration should be given in making these grants to projects that will benefit students of all institutions in the State. The products of these grants should be shared with all institutions in the State.

   In order to qualify for these funds, a campus must have a technology plan approved by its governing board and by the Maryland Higher Education Commission. $22 M

Total Recommended Five-Year Commitment **$94.3M**

TABLE 5. SUMMARY OF FUNDING RECOMMENDATIONS

(millions)

Purpose of Funding	FY 00	FY 01	FY 02	FY 03	FY 04	TOTAL
Development of a high-speed, broadband, digital Maryland Educational Network						
a) to USM for statewide connectivity	5	3	3	3	3	17
b) institutional network membership cost	1.54	1.54	1.54	1.54	1.54	7.7
State funding to aid member institutions in achieving baseline standards for resources.						
a) one-time expenditure for campus infrastructure needed to access network,	3	3	1.1			7.1
b) matching grant funds to aid in the purchase or upgrade of hardware and software in order to use network and meet baseline standards	5	5	5	5	4.5	24.5
c) a 20% match is recommended.						
Competitive matching grant program for colleges and universities that have achieved baseline standards for information technology resources for innovative programs and projects involving:	2	2	4	4	4	16
a) a public-private partnership;						
b) innovative uses of technology;						
c) responses to identified workforce training needs; and						
d) renewing technology resources.						
e) a 40% match is recommended.						
5-year competitive matching grant program to support faculty training and continuing professional development						
a) To develop technology training centers	4	2	1	1	1	9
b) To enhance institutions to support multi-media instruction	3	3	3	2	2	13
c) a 40% match is recommended.						
Total Recommended Five-Year Commitment	23.54	19.54	18.64	16.54	16.04	94.3

VII
SUMMARY OF RECOMMENDATIONS

NECESSARY COORDINATION

1. The State should fund the design, development, and implementation of a high-speed, broadband, digital Maryland Educational Network, based on international standards and protocols, open to other standards-based networks, to serve all of Maryland public education K-doctorate and independent colleges and universities, and to be available to other independent educational institutions at the lowest feasible cost. The Network should be managed and operated by the University System of Maryland with the control and oversight of the Maryland Educational Network Management Council, which will be broadly representative of all Network users.

2. The Maryland Educational Network should supply Internet access, data connectivity, digital video teleconferencing for instruction, technical consulting services, and other appropriate services to all Network member institutions.

3. The Maryland Educational Network will establish technical standards to which all participating institutions must conform.

4. The Maryland Higher Education Commission, in consultation with the segments of postsecondary education and in cooperation with the Council of Academic Library Directors, should develop a proposal for the creation of a Digital Library to share the resources of all Maryland academic libraries and to permit consortial purchasing of expensive electronic databases.

5. The Maryland Educational Network should make the resources of Maryland postsecondary education available to business, industry and State government through telecommunications. The Network should not be a vendor of telecommunication services but a provider of educational services.

ORGANIZATIONAL STRUCTURES

1. A Maryland Educational Network Management Council should be appointed by the Governor to oversee the design, development, and implementation of the Network. This Council should be composed of 8 presidents of public and independent colleges and universities, 4 representatives of private industry, 2 superintendents of local education agencies, a public school teacher, the Secretary of Higher Education, the State Superintendent of Schools, the Secretary of Health and Mental Hygiene, the Chief of Information Technology, a representative of public broadcasting, and a representative of public libraries. The Council should be chaired by the Secretary of Higher Education.

2. The Management Council will have the power to approve

   a) the Network design;
   b) the development of the Network;
   c) the implementation of the Network; and
   d) the annual budget of the Network.

3. The Management Council will review the guidelines developed by the Maryland Higher Education Commission for all grant funds to be distributed as a part of this initiative.

4. The Maryland Educational Network system operations office within the USM must be sufficiently staffed to provide appropriate leadership to information technology resource development in higher education. The management operations must be funded at a level competitive with other states with advanced technology networks. The system management office should provide "7x24" staffing (7 days per week, 24 hours per day) of a "help desk" for users of the Network.

5. An information technology clearinghouse, with a primary focus on distance education in Maryland, should be created and maintained by the Maryland Higher Education Commission.

6. The Maryland Educational Network may enter into long-term partnerships with high tech corporations and telecommunications companies for the development of new and marketable technologies and services. Any funds generated by these partnerships accruing to the State should be re-invested in the Network.

THE NEEDS OF INDIVIDUAL INSTITUTIONS

1. Each college and university campus should make certain defined baseline information technology resources and capabilities available to all students, faculty and staff. The State should fund a matching grant program, administered by the Maryland Higher Education Commission, to aid institutions in achieving these baseline standards for resources. The baseline standards should be developed by the institutions through the Educational Technology Policy Council and approved by the Maryland Higher Education Commission, in consultation with the management of the Network.

   a) Operating funds should be appropriated to aid in the one-time expenditure for campus infrastructure, including wide area networks and local area networks to allow campuses to achieve the baseline level of services.
   b) State matching grant funds should be available to aid in the purchase of equipment, hardware, and software needed for classroom instruction, laboratories, and other academic purposes to achieve the minimum level of resources.
   c) The Maryland Higher Education Commission must monitor the use of these funds to assure that baseline levels of resources and services are achieved.
   d) In order to qualify for these funds, a campus must have a technology plan approved by its governing board and by the Maryland Higher Education Commission

2. The State should fund a competitive matching grant program, administered by the Maryland Higher Education Commission, for colleges and universities to support the development of

institutional information technology resources when these can be shown to be compatible with the Maryland Educational Network proposed by this Commission. This program should be supported by State funding, either capital or operating. Preference should be given to projects which include

a) a public-private partnership;
b) innovative uses of technology;
c) responses to identified workforce training needs; and
d) renewing technology resources.

In order to qualify for these funds, a campus must have a technology plan approved by its governing board and by the Maryland Higher Education Commission

3. The State should make technology equipment and infrastructure expenditures associated with new capital construction or the renovation of academic buildings eligible for State funding. Any policy adopted must recognize the rapid depreciation of information technology resources.

4. The Maryland Higher Education Commission should expedite a study of the future need for the construction of additional classroom space on existing campuses in light of the impact of distance education.

5. The Maryland Higher Education Commission, in consultation with the segments of postsecondary education and the Educational Technology Policy Council, should review State laws and regulations to identify and repeal unnecessary regulatory barriers to the expanded use of distance education, so long as that instruction conforms to accepted standards of quality.

TOMORROW'S WORKFORCE

1. In order to assure that Maryland high school graduates will enter college with technology skills and to assure that adequate teacher training is required, by the year 2003,

   (a) graduates of public high schools should be computer literate;
   (b) faculty in teacher education programs should be required to demonstrate basic computer skills and an ability to incorporate multimedia into instruction; and
   (c) in order to be certified to teach in Maryland, prospective teachers should be able to demonstrate basic computer skills and the ability to use computers in multimedia instruction.

2. Every student in a public college or university should be competent in the use of computers and basic computer software – word-processing, spread sheets, and graphics – by the end of the sophomore year (or the completion of 60 credit hours).

3. Each classroom and instructional space in a college or university should be wired to permit multimedia instruction at a defined baseline level. The Maryland Higher Education Commission, in cooperation with the Department of Budget and Management, and in consultation with the Education Technology Policy Council, should develop the baseline requirements for information technology capabilities for instructional spaces.

4. The State should fund a 5-year competitive matching grant program, administered by the Maryland Higher Education Commission, to support faculty training and continuing professional development to encourage the design and use of multimedia instruction and distance learning applications. Consideration should be given in making these grants to projects that will benefit students of all institutions in the State. The products of these grants should be shared with all institutions in the State.

   In order to qualify for these funds, a campus must have a technology plan approved by its governing board and by the Maryland Higher Education Commission.

APPENDIX

1. Executive Order 01.01.1998.02
2. Individuals Testifying before the Commission
3. Members of the General Assembly Contributing to the Commission's Deliberations
4. List of Meetings
5. Distance Learning Users Council Matrix of Information Technology Functions and Parties Responsible for Implementation

EXECUTIVE ORDER
01.01.1998.02

Governor's Commission on Technology in Higher Education

WHEREAS, The exponential growth in the speed, power and capacity of computers and rapid advances in telecommunications are altering the environment in which higher education institutions must respond to the needs of Maryland's citizens;

WHEREAS, There has been and will continue to be an explosion in distance education which holds the promise of access to higher education from home and from the workplace, and which will change forever the nature of the traditional campus;

WHEREAS, Maryland is determined to have a public higher education system of highest quality, efficiently operated, which is at the forefront of technological innovation;

WHEREAS, The economic competitiveness of the State will depend on the ability of the institutions of higher education to utilize advanced technologies for teaching, research and public services and on the graduation of students who are knowledgeable about advanced technologies;

WHEREAS, The purchase, implementation, and maintenance of advanced telecommunications and networking technologies as well as the installation of telecommunications infrastructure both statewide and on each campus promises to be an extremely expensive undertaking for the State, with competing requests for funding already appearing; and

WHEREAS, The State needs an objective body to make a comprehensive review of technology in higher education and to provide a report for the State to follow in establishing a statewide infrastructure and funding of telecommunications and information technology in higher education.

NOW, THEREFORE, I, PARRIS N. GLENDENING, GOVERNOR OF THE STATE OF MARYLAND, BY VIRTUE OF THE AUTHORITY VESTED IN ME BY THE CONSTITUTION AND THE LAWS OF MARYLAND, HEREBY PROCLAIM THE FOLLOWING ORDER, EFFECTIVE IMMEDIATELY:

A. The Governor's Commission on Technology in Higher Education is hereby created to provide the Governor with a report on:

1. The State's vision of higher education in the future and the attendant technology needs;
2. An evaluation of the nature of the jobs of the future and technology resources necessary both to prepare students for the future workplace and the faculty that will be responsible for that preparation;

3. The future technology needs of individual institutions of higher education and what resources will be needed in order to allow these institutions to fulfill their missions in the next century;

4. Any necessary coordination of technology resources between institutions of higher education;

5. The appropriate amounts of State expenditures in providing the funding needed to meet these future needs, as well as the appropriate roles of the State and higher education institutions in funding for hardware and software resources, ongoing maintenance, and telecommunications infrastructure in capital projects;

6. Any organizational structures needed at the State or institutional level for the effective use of information technology.

B. The Commission shall consist of eleven members to be appointed by the Governor. These members shall have an interest or expertise in advanced technology business and industry, or education, and broadly representative of several regions of the State.

C. The Governor shall designate a chairperson from among the members of the Commission.

D. The Commission shall complete its duties by September 15, 1998.

E. The members shall serve without compensation, but may be reimbursed for reasonable expenses incurred in the performance of their duties and in accordance with the State Standard Travel Regulations and as provided in the State budget.

F. The Commission shall submit its report on the items listed in Section A of this Order to the Governor on or before September 15, 1998.

GIVEN Under My Hand and the Great Seal of the State of Maryland, in the City of Annapolis, this 16th Day of January, 1998.

Parris N. Glendening
Governor

ATTEST:
John T. Willis
Secretary of State

LIST OF INDIVIDUALS TESTIFYING

before the
Governor's Commission on Technology in Higher Education

Dr. J.B. Mathews
Senoir Policy Advisor, Southern Regional Education Board
Former Vice Chancellor for Information and Instructional Technology
University System of Georgia Board of Regents

Dr. Richard T. Hezel
Hezel Associates

Dr. Tom West
Vice Chancellor for Information Technology
California State University System

Dr. William Troxler, President, Capitol College
Chair, Educational Technology Policy Council
of the Maryland Higher Education Commission

Dr. Joseph Shields, President, Carroll Community College
Representing the Maryland Association of Community Colleges

Barbara Reeves
Maryland State Department of Education

Dr. J. Elizabeth Garraway, President
Maryland Independent College and University Association

Leslie E. Hearn, Executive Director
Office of Information Technology
Department of Management and Budget

Dr. Freeman Hrabowski, President
University of Maryland, Baltimore County

Dr. Joann Boughman, Vice President for Acad. Affairs and Graduate Dean
University of Maryland Baltimore

Dr. Gregory Geoffroy, Provost
University of Maryland College Park

Dr. James Alexander, Chairman
Faculty Advisory Council to the Maryland Higher Education Commission

Dr. Hoke Smith, President
Towson State University

John Dillon, Vice President, External Affairs
Bell Atlantic-Maryland

Dyan L. Brasington, President
High Technology Council of Maryland

Dr. Donald Langenberg, Chancellor
University System of Maryland

Dr. John Toll, President
Washington College

Dr. Stephen J. Herman, President, Garrett Community College
Chair, Distance Learning Users Council of the Maryland Higher Education Commission

J. Maurice Travillian, Assistant State Superintendent for Libraries
Maryland State Department of Education

James Neal, Director, Sheridan Library, Johns Hopkins University
Congress of Academic Library Directors

Fred Lazarus IV, President
Maryland Institute, College of Art

Dr. H. Mebane Turner, President
University of Baltimore

Dr. William C. Merwin, President
Salisbury State University

Dr. Earl Richardson, President
Morgan State University

Richard Armbruster, Vice President, TESST Technology Institute
Maryland Association of Private Career Schools

Frank Peto, Executive Director
Regional Education Service Agency

Dr. Mary Ellen Petrisko, Vice President Academic Affairs
University of Maryland University College

University System of Maryland Library Directors

Dr. Steven Knapp, Provost and Vice-President of Academic Affairs
The Johns Hopkins University

Members of the General Assembly Contributing to the Commission's Deliberations

The Honorable Leonard H. Teitelbaum
Senate of Maryland

The Honorable Kumar Barve
Maryland House of Delegates

The Honorable Robert L. Frank
Maryland House of Delegates

The Honorable Samuel I. (Sandy) Rosenberg
Maryland House of Delegates

LIST OF MEETINGS
March - September, 1998

of the

Governor's Commission on Technology in Higher Education

The Commission met 8 times. Each meeting, except the first and last, was an all-day meeting from 9:30 a.m. until 3:00 p.m. All meetings but the first and last were hosted by the University of Baltimore.

Meeting 1 (March 11)	Primarily organizational. The Commission reviewed its charge. There was a brief orientation to the Maryland higher education system, to distance learning, and to the telecommunications issues involved. Various reading materials were distributed.
Meeting 2 (April 16)	The Commission reviewed national trends and practices and heard presentations by national experts.
Meeting 3 (May 29)	The Commission conducted a public hearing on the status of educational technology in Maryland and the needs of the institutions/segments of higher education.
Meeting 4 (June 4)	A second public hearing was held.
Meeting 5 (June 29)	A working session. The Commission reviewed alternatives and instructed staff on the nature of the final report.
Meeting 6 (July 15)	The Commission received a draft report and gave staff guidance in revisions.
Meeting 7 (August 13)	The Commission received written public comments on the draft report and discussed further revisions in their draft report and recommendations.
Meeting 8 (Sept. 9)	The Commission reviewed and adopted the final report.

Distance Learning Users Council
Matrix of Information Technology Functions and Parties Responsible for Implementation

Functions/ Activities	Recommended Responsible Party		
	Statewide Responsibility	Segmental/Campus Responsibility	Other Entities (Specify)
Statewide high-speed connectivity	There should be an integrated statewide shared network serving the needs of Maryland's citizens, including education needs. It should provide for varying speeds and bandwidth. No one user should decide policy. The governance structure should include representatives of all education providers in the decisionmaking process. Management should be by a competent educational entity.	The segments and educational institutions should have a role in establishing the standards for the network.	The Office of Information Technology (OIT) should have a role to assure compatibility with other State networks/plans.
Campus infrastructure	• The State should set minimum standards/expectations for educational institutions. State funds will be needed for reaching standards initially, but campuses should finance maintenance, repairs and upgrades. • The State should encourage cooperative approaches to purchasing of software, hardware, and services.	Educational institutions should establish their needs based on minimum standards. Campuses should confront the need for all students to have a computer. Each educational institution should have a plan for developing its infrastructure and equipment.	
Internet Service	Internet service should be provided by the State network, but institutions should be free to seek lowest price providers. This will make the State network compete.		

Functions	Statewide Responsibility	Segmental/Campus Responsibility	Other Entities (Specify)
Faculty training/ Professional development	The State should require educational institutions participating in the network to have a plan for training and professional development of system users. The State should encourage collaborative efforts to deliver instruction, training, and professional development. Grant funds should be provided to support this training.	User groups should be responsible for managing funds for faculty training and development and for delivering the training/development.	
Curriculum design/ development	• The State should facilitate the establishment of a distance learning cooperative for curriculum design and development. • The State should aid campuses with targeted grant funds.	Curriculum development is a campus responsibility.	College/business partnerships are possible in curriculum development and design.
Electronic access to learning resources *Virtual Library*	The State should provide incentives for cooperative library services and resource sharing.		
Information Clearinghouse	There should be a statewide clearinghouse for sharing information on distance education–training opportunities, courses offered, available grants, etc. An easily accessible, comprehensive website could perform this function.	The segments/educational institutions should be responsible for providing information to the statewide clearinghouse as well as maintaining informational websites that could be linked to the statewide clearinghouse.	
Coordination of Distance Education	This is not a stand-alone issue, but should be seen within the context of other activities such as the statewide network. A formal consortium may be useful in achieving coordination.		
Increase in graduates in technology fields	The State should provide incentives both to students (such as the Science and Technology Scholarships program) and to institutions to increase the number of graduates in technology fields.	This is a responsibility not only of higher education but of the entire spectrum of education K-16.	K-12 schools should address this problem.

GLOSSARY OF TERMS

A

Access: The method of connecting a communication circuit from the user's premise to the nearest carrier office.

Alternate routing (in PABX technology): A method of completing calls that uses another path when the primary circuit is unavailable, out of service, or busy.

Analog: Related to continuously variable physical property, such as voltage, pressure, or rotation. An analog device can represent an infinite number of values within the range the device can handle.

ANSI (American National Standards Institute): Voluntary organization of over 1300 members including the large computer companies that create standards for the computer industry.

Application: A program or group of programs designed for end users. Applications software such as spreadsheets and word processors cannot run without an operating system and system utilities.

ASCII (American Standard Code For Information Interchange): A 7-bit-plus-parity character set or code established by ANSI to achieve compatibility between data services,

ASCII terminal. A terminal that uses ASCII; usually synonymous with asynchronous terminal and with dumb terminal.

Asynchronous: 1. Technical: Not occurring at predetermined or regular intervals. Communications in which data can be transmitted intermittently rather than in a steady stream. 2. In distance learning, interaction between student and teacher or other students is delayed,(*e.g.*, as through e-mail), not live and immediate.

ATM (Asynchronous Transfer Mode): A network technology based on transferring data in cells or packets of a fixed size. The cell used with ATM is relatively small compared to units used in earlier technologies. The small, constant cell size allows ATM equipment to transmit video, audio, and data over the same network, and at high speed.

B

Backbone: The main wire that connects nodes. The main network connections comprising the Internet are a backbone.

Bandwidth: 1. The difference. expressed in kilo- or Megahertz, between the lowest and highest frequencies in a spectrum that allows data to be transmitted without causing undue errors. 2. The number of bits per second a channel can handle.

Baud: Unit of signaling speed. The speed in baud is the number of discrete conditions or signal events per second.

Bit: Short for binary digit, the smallest unit of information on a machine. A single bit can hold only one of two values: 0 or 1. More meaningful information is obtained by combining consecutive bits into larger units such as bytes.

Bit-mapped graphics: The hardware and software that represent graphics images as bit maps, such as BMP, GIF, PCX, and TIFF. A bit map is a representation of a graphics image consisting of rows and columns of dots. The more bits used to represent a dot, the more colors and shades can be represented. The density of the dots or resolution, expressed in dots per inch (dpi) or by the number of rows and columns (640 by 480), determines the sharpness of the image.

Bridge: 1. Equipment which connects different LANs allowing communication between devices on separate LANs. Bridges will connect LANs with different hardware and different protocols. 2. The interconnection between two networks using the same communications method, the same kind of transmission medium, and the same addressing structure; also the equipment used in such an interconnection.

Broadband: Colloquially, broadband describes communication channels with bandwidth great enough to transmit full-motion video. Technically, broadband specifies only a multichannel medium, as contrasted with baseband (only one channel).

Broadcast: Transmission of a signal from a single source to multiple receivers, not interactive.

Browser: A software application used to locate and display Web pages. Netscape Navigator and Microsoft Internet Explorer are the most popular Web browsers.

Bulletin board system (BBS): An electronic message center. Most BBSs serve specific groups, allowing users to view messages left by others and post their own messages.

Byte: Binary term, a unit of storage capable of holding one character. On most computers, a byte is 8 consecutive bits. Large amounts of memory are measured in kilobytes (1,024 bytes), megabytes (1,048,576 bytes), and gigabytes (1,073,741,824 bytes). A disk that holds 1.44 megabytes is capable of storing approximately 1.4 million characters, or about 3,000 pages of information.

C

CalRen: The California Research and Education Network.

Channel: A communications path between two computers or devices. It can refer to a physical medium (wire) or a set of properties that distinguishes one channel from another. For example, TV channels refer to particular frequencies at which radio waves are transmitted.

Chat: Real-time communication between two users via computer. Once initiated, either user can enter text by typing on the keyboard, and the entered text will appear on the other user's monitor.

Chat room: A virtual room where a chat session takes place. A chat room is really a channel.

Circuit: 1. In data communications, a means of 2-way communications between two points, consisting of transmit and receive channels. 2. In electronic design, one or more components that act together to perform one or more functions.

CIT: Chief of Information Technology, the executive office of the Office of Information Technology, State of Maryland. (See OIT.)

Client-server architecture: A network architecture in which each computer or process on the network is either a client or a server. Servers are powerful computers dedicated to managing disk drives, printers, or network traffic. Clients are computers or workstations on which users run applications.

CO lines: These are the lines connecting your office to your local telephone company's Central Office which in turn connects you to the nationwide telephone system.

Codec: Coder-decoder. A computer with specialized software installed to convert video into digital signals for transmission and also to receive digital signals and convert them into video.

Compact disc-read-only memory (cd-rom): A type of optical disk capable of storing up to 1 GB of data, although the most common size is 630MB. A single CD-ROM has the storage capacity of 700 floppy disks.

Connectivity: The ability of a program or device to link with other programs or devices.

Compression: Coding that compacts data (in digital form) for storage or in order to conserve bandwidth for transmission.

Compressed video: Colloquially, a term for several commercial products that transmit visual images as digital information in a compressed mode, resulting in a visual image that must be reconstituted on a video monitor, resulting in some jerkiness and discontinuity.

Computer-assisted instruction: Courses may be delivered through a wide-area computer network, with students having real-time interaction with their instructor although they are at separate locations. This may be combined with a bulletin board for students and teacher to communicate with each over by posting questions and receiving responses.

CPU. Central processor unit of a computer. Contains the arithmetic unit, internal program and data storage memory, control circuits and operating controls.

CSU: California State University.

D

Database: A collection of information organized so a computer can select desired data; an electronic filing system.

Download: To copy data, usually an entire file, from a main source to a peripheral device. Often used to describe copying a file from an on-line service or BBS, or copying a file from a network file server to a computer on the network.

Data communications: The processes, equipment, and/or facilities used to transport signals from one data processing device at one location to another data processing device at another location.

Data compression: Storing data in a format that requires less space than usual. Compressing or packing data is especially useful in communications because it enables devices to transmit the same amount of data in fewer bits.

DBM: Department of Budget and Management, State of Maryland.

Digital: Discretely variable as opposed to continuously variable. Data characters are coded in discrete, separate pulses or signal levels. Contrast with ANALOG.

Digital PBX: A PBX that switches voice and data traffic as digital signals.

Distributed architecture: In LAN technology, a LAN that uses a shared communications medium; used on bus or ring LANs; uses shared access methods.

DLUC: The Distance Learning Users Council, an advisory group to the Maryland Higher Education Commission.

DS-0: The basic digital telephony channel. On DS-0 carries one voice channel equivalent of data.

DS-1: A cable carrying a multiplexed channel of 24 DS-0 channels (1.544 Mbps). (See T-1)

DS-3: A cable carrying a multiplexed channel of 28 DS-1 channels (45 Mbps, 672 DS-0 channels). (See T-3.)

Duct: A pipe, tube or conduit through which cables or wires can be passed.

E

EDI (Electronic Data Interchange): The transfer of data between different companies or organizations using networks such as the Internet.

E-mail: Electronic mail, or the transmission of messages over communications networks.

Ethernet: A local-area network protocol developed by Xerox in cooperation with DEC and Intel in 1976. Ethernet uses a bus typology and supports data transfer rates of 10 or 100Mbps.

ETPC, Educational Technology Policy Council: An advisory council to the Maryland Higher Education Commission.

Extended LAN: Two traditional Ethernet LANs joined together by a bridge. Bridges can be used to configure an extended LAN composed of up to eight traditional LANs.

F

FDDI (Fiber Distributed Data Interface): A set of ANSI protocols for sending digital data over fiber optic cable. FDDI networks are token-passing networks and can support data rates up to 100 Mbps. FDDI networks are typically used as backbones for wide-area networks. FDDI-2, an extension of FDDI, supports transmission of voice and video information as well as data.

FDLN: Florida Distance Learning Network.

Feeders: The main lines delivering power to a distribution system.

Fiber optics: A technology that uses glass or plastic threads (fibers) to transmit data. A fiber optic cable consists of a bundle of glass threads, each of which is capable of transmitting messages at close to the speed of light. Fiber optic cables have much greater bandwidth than metal cables and can thus carry more data.

Firewall: A system designed to prevent unauthorized access to or from a private network.

FIRN: Florida Information Resource Network.

4CNet: A computer network linking the California State University System's campuses.

FTP (File Transfer Protocol): The protocol used on the Internet for sending files.

Full-motion video: Images displayed at 30 frames per second. A high-quality decoder will display full-screen, smooth video animation. Cheaper hardware or software solutions can produce choppy or lower-resolution images.

G

Gateway: A combination of hardware and software that links two different types of networks.

Gigabyte: One gigabyte is equal to 1,024 megabytes.

GSAMS: Georgia Statewide Academic and Medical System.

H

Hardware: Refers to boards, chips, disks, disk drives, display screens, keyboards, printers, and other physical objects you can touch. In contrast, software is untouchable--the computer instructions or data that are stored electronically.

Hot links: Icons that when you click on them take you to another object in a Hypertext system such as the World Wide Web.

HTTP: Hypertext Transfer Protocol, the underlying protocol used by the World Wide Web.

Hub: (In LAN technology) The center of a star topology network or cabling system.

Hypermedia: An extension to hypertext that supports linking graphics, sound, and video elements in addition to text. The World Wide Web is a partial hypermedia system since it supports graphical hyperlinks and links to sound and video files.

Hypertext: A database system in which objects (e.g., text, pictures, sound, programs) can be linked to each other. When you select an object, you can see and move to all the other objects linked to it, even if they have different forms. The icons you select to view associated objects are called hypertext links or buttons.

I

Interactive: Accepting input from a human. Interactive computer systems are programs that allow users to enter data or commands. A non-interactive program is one that, once started, continues without requiring human contact.

Interface: A shared boundary defined by common physical interconnection characteristics, signal characteristics, and meanings of interchanged signals.

Internet: A global web connecting more than a million computers located in over 100 countries. As of November 1997, there were an estimated 30 million Internet users.

Internet service provider (ISP): A company that provides access to the Internet.

ISDN (Integrated Services Digital Network): An international communications standard for sending voice, video, and data over digital telephone lines. ISDN requires special metal wires and supports data transfer rates of 64 Kbps (64,000 bits per second

ITB: Information Technology Board. A board appointed by the Governor to advise him on all aspects of telecommunications which affect State government. Most of the State departments and agencies are represented by their chief executive officer.

IVN: The Interactive Video Network of the University System of Maryland.

J

Java: A high-level programming language developed by Sun Microsystems. It is an object-oriented language similar to C + +, but simplified to eliminate common programming errors. Java is well suited for the World Wide Web.

K

Kb (kilobit): 1024 bits or 2^{10} bits of information (usually used to express a data transfer rate).

Kbps: Kilobits per second. 2^{10} bps = 1024 bps.

L

LAN: Local Area Network: privately owned network offering a reliable high-speed communications channel for connecting information processing equipment within a limited geographic area.

LATA: Local access and transport area. The Federal court decree formalizing the divestiture of AT&T divided the country into LATAs, which often correspond to local area codes. A LATA defines the boundary of a local exchange carrier. (To cross a LATA boundary, one must use a long-distance carrier.)

LISTSERV: When in all caps, refers to an automatic mailing list server developed for BITNET in 1986. When e-mail is addressed to the listserv, it is automatically broadcast to everyone on the list. LISTSERV is a commercial product; listserv is a generic term for any mailing list server.

M

MACC: The Maryland Association of Community Colleges.

Mbps: Megabits per second. 2^{20} bps = 1,048,576 bps = 1,024 Kbps.

MDLN: The Maryland Distance Learning Network.

Megabyte (M or MB): One megabyte equals 1,048,576 bytes of storage. When used to describe data transfer rates (e.g., MBps), it refers to one million bytes.

MHEC: The Maryland Higher Education Commission.

MICUA: The Maryland Independent College and University Association.

Multiplex: To transmit two or more messages simultaneously through the same communication channel.

Multimedia: The use of computers to present text, graphics, video, animation, and sound in an integrated way. CD-ROMs are the typical media.

N

Network: A group of two or more computer systems linked together. Often characterized by their topology or geometric arrangement (bus, star, or ring), their protocol or rules and signals for communicating (e.g., Ethernet, token-ring), their architecture (peer-to-peer, client/server), and their geographic dispersion (local area or wide area). Computers on a network are sometimes called nodes. Computers and devices that allocate resources for a network are called servers.

Network topology. The physical and logical relationship of nodes in a network. Networks are typically of either a star, ring, tree or bus topology or some hybrid combination thereof.

O

OIT: Office of Information Technology, State of Maryland, housed in the Department of Budget and Management and charged with coordinating the State's investments in information technology of all kinds.

OIIT: Office of Information and Instructional Technology, University System of Georgia.

On-line service: A business that provides subscribers with data transmitted over telecommunications lines.

Operating system: A program needed by a computer to run other programs. Operating systems perform the basic tasks of recognizing input from the keyboard, sending output to the display screen, keeping track of files and directories on disks, and controlling peripheral devices such as disk drives and printers.

Optical fiber: A very thin, flexible, glass or plastic fiber carrying high-bandwidth digital or analog signals in the form of pulses of light. Fiber can carry a thousand times more information than conventional copper wire.

P

PeachNet: A statewide computer network in Georgia serving all educational institutions, providing data transfer, e-mail, and Internet transfer.

Private branch exchange (PBX): A private switching system usually serving an organization, such as a business or government agency, and located on the customer's premises. It switches calls both inside a building or premises and outside to the telephone network, and can sometimes also provide access to a computer from a data terminal.

Protocol: An agreed-upon format for transmitting data between two devices.

R

Real-time: Used to describe a computer process that operates at sufficient speed to appear interactive, or immediately responsive, to a user.

Reliability: The likelihood of trouble-free performance from a component or an assembly.

Router: A station which uses upper level protocols to control network communication between other stations.

S

Server: A computer or device on a network that manages network resources. A file server is a computer and storage device dedicated to storing files. Any user on the network can store files on the server. A print server is a computer that manages one or more printers. A network server is a computer that manages network traffic.

Software: Computer instructions or data that can be stored electronically.

SONET: Synchonous optical network: One of several emerging systems developed to take advantage of fiber-optic technology. Provides extremely fast transmission of data over very wide bandwidth.

Standard: A definition or format that has been approved by a recognized standards organization or is accepted as a de facto standard by the industry.

Star topology: A network interconnection scheme in which one central node has links to all other nodes which have no direct connections to each other.

Streaming: A technique for transferring data such that it can be processed as a steady and continuous stream. Important for Internet users because most do not have the capability to download large multimedia files quickly.

Synchronous: Occurring at regular intervals, regulated by a clock. Communication within a computer is usually synchronous, while communication between computers and other devices is usually asynchronous in that it can occur at any time and at irregular intervals.

T

T-1 carrier: A dedicated phone connection supporting data rates of 1.544Mbits per second. A T-1 line consists of 24 channels, each supporting 64Kbits per second.

T-3 carrier: A dedicated phone connection supporting data rates of about 45Mbits per second. A T-3 line consists of 672 individual channels, each supporting 64Kbits per second. T-3 lines are used mainly by ISPs connecting to the Internet backbone and for the Internet backbone itself. T-3 lines are sometimes called DS3 lines.

TCP/IP: (Transmission Control Protocol/Internet Protocol): The suite of communications protocols used to connect hosts on the Internet. TCP/IP is built into the UNIX operating system used by the Internet, and is thus the de facto standard for transmitting data over networks.

Telco: Any local telephone company.

Terminal: Any device capable of sending or receiving data over a data communications channel

Transport: The element of communications equipment concerned with moving messages from one point to another. The physical aspect of a network--wires, cables, microwave links, etc.

U

UMATS: The University of Maryland Academic Telecommunications System.

Upload: To transmit data from a computer to a bulletin board service, mainframe, or network.

User group: An organization of users of a particular electronic network to represent users concerns to system managers and vendors.

USENET: A worldwide bulletin board system that can be accessed through the Internet or other online services. The USENET contains thousands of newsgroups that cover every imaginable interest.

USM: The University System of Maryland.

W

Wide area network (WAN): A network of computers dispersed geographically and usually connected by telephone lines or radio waves.

World Wide Web: A system of Internet servers that support documents formatted in HTML, providing links to other text, graphics, audio, and video files by clicking on icons. Not all Internet servers are part of the World Wide Web. Browsers make it easy to access the World Wide Web.